COMPTES RENDUS
(DOKLADY)
DE L'ACADÉMIE DES SCIENCES DE L'URSS

NOUVELLE SÉRIE

1944

IMPERIAL MYCOLOGICAL
JUN 1947
INSTITUTE

VOLUME XLIII

№ 6

ÉDITION DE L'ACADÉMIE DES SCIENCES DE L'URSS
MOSCOU

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NOUVELLE SÉRIE

12-me année

Paraissant tous les dix jours

1944

VOLUME XLIII, № 6

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Moscou 1944

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

MATHEMATICS

ON THE TRANSFINITE SPACES E AND ON THE CONTINUUM HYPOTHESIS

By ISAIAH MAXIMOFF

(Communicated by A. N. Kolmogoroff, Member of the Academy, 20. XI. 1943)

In an earlier work (1) the author has proved that the set E_x of all the sequences

$$x=\{x_0, x_1, x_2, \ldots, x_\alpha, \ldots\},\ 0\leqslant\alpha\leqslant\beta<\Omega_r$$

and of all the sequences

$$x=\{x_0, x_1, x_2, \ldots, x_\alpha, \ldots\},\ 0\leqslant\alpha<\Omega_r$$

where $x_0=0, 1, 2, 3, \ldots, \gamma, \ldots (\gamma<\Omega_r)$ and $x_\alpha=1, 2, 3, \ldots, \gamma, \ldots$ if $\alpha\neq 1$, is the continuum of the power $\aleph_r^{\aleph_r}$.

Now we introduce the following definitions.

Definition 1. A set of all the elements x such that $a<x<b$ will be called the interval (a, b) with the boundaries a and b.

Let E be any set of points in E_x^r.

Definition 2. A point x_0 of E_x^r will be called a limit (I)-point for E if every interval containing x_0 contains at least a point x_1 of E different from x_0, $x_1\neq x_0$.

We denote by $E_I^{(1)}$ the set of all the limit (I)-points for E.

Definition 3. We shall say that a set E is closed (I) if $E_I^{(1)}\subset E$.

Definition 4. We shall say that a set E is perfect (I) if $E_I^{(1)}=E$.

Let $y=f(x)$ be any univocal function defined in any set $E\subset E_x^r$. We denote by $f(E)$ the set of all the points $f(x)$ where $x\in E$, and suppose that $f(E)\subset E_x^r$.

Definition 5. A function $y=f(x)$ will be called regular in E if for every pair (x_1, x_2) of points x_1 and x_2 of E such that $x_1\neq x_2$ we have $f(x_1)\neq f(x_2)$.

Definition 6. A function $y=f(x)$ will be called continuous (I) in E if for every pair (x_0, y_0), where $y_0=f(x_0)$, $x_0\in E$, there corresponds to every interval $i(y_0)$ containing y_0 a certain interval $i(x_0)$ containing x_0 and having the following property: from $x\in i(x_0)E$ it follows $y=f(x)\in i(y_0)f(E)$.

Definition 7. A set $E\subset E_x^r$ will be called hypermeasurable (I) if E either contains a perfect (I) set or is of the power $\leqslant\aleph_r$.

Definition 8. A function $y=f(x)$ defined in E will be called hypermeasurable (I) in E if the set E contains a perfect (I) set P in which $f(x)$ is continuous (I).

Transfinite Space E_x^{rk}

Let

$$x=\{x_0, x_1, x_2, \ldots, x_\alpha, \ldots\},\ \alpha<\Omega_{r+k} \qquad (1)$$

be a sequence of points x_α of the space E_x^r. This sequence will be called a point of the transfinite space E_x^{rk}.

We shall say that a point

$$x' = \{x'_0, x'_1, x'_2, \ldots, x'_\alpha, \ldots\} \qquad (\alpha < \Omega_{r+k}) \tag{2}$$

of E_x^{rk} is equal to a point

$$x'' = \{x''_0, x''_1, x''_2, \ldots, x''_\alpha, \ldots\} \qquad (\alpha < \Omega_{r+k}) \tag{3}$$

of E_x^{rk} if $x'_\alpha = x''_\alpha$ for every $\alpha < \Omega_{r+k}$.

In the contrary case we write $x' \neq x''$.

We shall denote by ρI the point

$$x = \{x_0, x_1, x_2, \ldots, x_\alpha, \ldots\}, \ \alpha < \Omega_{r+k}$$

of E_x^{rk} such that

$$x_0 = x_1 = x_2 = \ldots x_\alpha \ldots = \rho \in E_x^r$$

Let E be any set of points of E_x^{rk} and let

$$\bar{x} = \{\bar{x}_0, \bar{x}_1, \bar{x}_2, \ldots, \bar{x}_\alpha, \ldots\}, \ \alpha < \Omega_{r+k}$$

be any point of E. We shall denote (i) by $\{\bar{x}\}_\alpha$ the point $\bar{x}_\alpha$ of E_x^r, $\bar{x}_\alpha = \{\bar{x}\}_\alpha$ (ii) by $\{E\}_\alpha$ the set of all the points $\{\bar{x}\}_\alpha$ where $\bar{x} \in E$.

A set $I \subset E_x^{rk}$ will be called an interval in E_x^{rk} if $\{I\}_\alpha$ is an interval in E_x^r for every $\alpha < \Omega_{r+k}$. We shall further say that a set E, $E \subset E_x^{rk}$, is closed (I), perfect (I), hypermeasurable (I), if the set $\{E\}_\alpha$ is, respectively, closed (I), perfect (I), and hypermeasurable (I) for every $\alpha < \Omega_{r+k}$.

Let $y = f(x)$ be any univocal function defined in any set $E \subset E_x^r$. We denote by $f(E)$ the set of all the points $f(x)$ where $x \in E$, and suppose that $f(E) \subset E_{xr}^{rk}$.

A function $y = f(x)$ will be called special in E, $E \subset E_x^{rk}$, if

$$f(x) = \{f_0(x_0), f_1(x_1), f_2(x_2), \ldots, f_\alpha(x_\alpha) \ldots\} \quad (\alpha < \Omega_{r+k})$$

for every point

$$x = \{x_0, x_1, x_2, \ldots, x_\alpha, \ldots\} \quad (\alpha < \Omega_{r+k})$$

of the set E, $f_\alpha(x_\alpha)$ being any univocal function in $\{E\}_\alpha$ for every $\alpha < \Omega_{r+k}$.

A special function $f(x)$ in E, $E \subset E_x^{rk}$, will be called continuous (I), hypermeasurable (I) in E if $\{f(x)\}_\alpha = f_\alpha(x_\alpha)$ is respectively continuous (I), hypermeasurable (I) in $\{E\}_\alpha$ for every $\alpha < \Omega_{r+k}$.

From this it follows that a function $f(x)$ defined in E, $E \subset E_x^{rk}$, is hypermeasurable (I) in E if E contains a perfect (I) set P such that $f(x)$ is continuous (I) in P.

We denote by E_1 the set of all the points

$$x = \{x_0, x_1, x_2, \ldots, x_\alpha, \ldots\}, \ \alpha < \Omega_{r+k}$$

of E_x^{rk} having the following property: one of the elements $x_0, x_1, x_2, \ldots, x_\alpha, \ldots (\alpha < \Omega_{r+k})$ of E_x^r is the rational point $\{2\}$ of E_x^r and every other element is the rational point $\{1\}$ of E_x^r.

Let $\overline{|\alpha|}$ be the point $x = \{x_0, x_1, x_2, \ldots, x_\alpha, \ldots\}$ of E_1 such that $x_\alpha = \{2\}$ and $x_{\alpha_1} = \{1\}$ for $\alpha_1 \neq \alpha$.

Let (a_ν, b_ν) be the interval determined in the following manner: 1) if $\nu = \alpha$, then a_ν is the rational point $\{1, 9\}$ of E_x^r and b_ν is the rational point $\{2, 1\}$ of E_x^r; 2) if $\nu \neq \alpha$, then a_ν is the rational point $\{0, 9\}$ of E_x^r and b_ν is the rational point $\{1, 1\}$ of E_x^r. Evidently, the interval $i = \{i_0, i_1, i_2, \ldots, i_\nu, \ldots\} \subset E_x^{rk}$ where $i_\nu = (a_\nu, b_\nu)$ contains one and only one point $\overline{|\alpha|}$ of E_1.

We denote by E_2 the set of all the points $x = \{x_0, x_1, x_2, \ldots, x_\alpha, \ldots\}$, $\alpha < \Omega_{r+k}$; such that $x_0 = x_1 = x_2 = \ldots = x_\alpha = \ldots = \rho \in E_x^r$.

Now we consider a correspondence

$$\alpha = Z(\rho) \tag{4}$$

between the numbers α, $1 \leqslant \alpha < \Omega_{r+k}$, and the points ρ of E_x^r. It is easily seen that we can replace the correspondence (4) by the equivalent correspondence

$$\left|\underline{\alpha}\right| = Z(\rho I) \tag{5}$$

between the points $\left|\underline{\alpha}\right|$ of E_1 and the points ρI of E_2.

We shall say that any function $f(x)$ regular in E_2 is of the class (NP) if $E_1 \neq f(E_2)$, and is of the class (Z) if $E_1 = f(E_2)$.

Theorem 1. *Every special function $f(x)$ which is continuous (I) and regular in E_2 belongs to the class (NP).*

Proof. We admit that the function $f(x)$ does not belong to the class (NP). Since $f(x)$ is regular in E_2, we have: $E_1 = f(E_2)$. Let x_0 be any point of the set E_2. In virtue of the equality $E_1 = f(E_2)$ the point $f(x_0)$ belongs to the set E_1; therefore we denote the point $f(x)$ by $\left|\underline{\alpha}\right|$, $\left|\underline{\alpha}\right| = f(x_0)$. But $f(x)$ is continuous (I) in E_2, consequently, to every interval $I\left(\left|\underline{\alpha}\right|\right)$ containing $\left|\underline{\alpha}\right|$ corresponds a certain interval $I(x_0)$ containing x_0, in such a manner that when x runs over the set $I(x_0)E_2$, then $f(x)$ runs over a set H contained in $I\left(\left|\underline{\alpha}\right|\right) f(E_2)$. We choose the interval $I\left(\left|\underline{\alpha}\right|\right)$ which contains one and only one point $\left|\underline{\alpha}\right|$ of the set E_1. Under this condition the set $I\left(\left|\underline{\alpha}\right|\right) E_1$ consists of one and only one point $\left|\underline{\alpha}\right|$, consequently, the power of the set $I\left(\left|\underline{\alpha}\right|\right) E_1 < \aleph_0$ and the power of the set $I(x_0)E_2 > \aleph_0$. Since $f(x)$ is regular in E_2, the set H of all the points where $x \in I(x_0)E_2$ has also the power $> \aleph_0$. This is impossible because $H \subset I\left(\left|\underline{\alpha}\right|\right) E_1$.

Theorem 2. *Every special function $y = f(x)$ which is hypermeasurable (I) and regular in E_2 belongs to the class (NP).*

Proof. We admit that the function $f(x)$ does not belong to the class (NP). Since $f(x)$ is regular in E_2, we have: $E_1 = f(E_2)$. Further, $f(x)$ is supposed hypermeasurable (I) in E_2, consequently, E_2 contains a perfect (I) set F in which $f(x)$ is continuous (I). Let x_0 be any point of F and $\left|\underline{\alpha}\right| = f(x_0)$. Evidently, $\left|\underline{\alpha}\right| \in f(F)$. Since $f(x)$ is continuous (I) in F and $x_0 \in F$, to every interval $I\left(\left|\underline{\alpha}\right|\right)$ containing $\left|\underline{\alpha}\right|$ corresponds a certain interval $I(x_0)$ containing x_0, in such a manner that when x runs over the set $I(x_0)F$, then $f(x)$ runs over a set Q contained in $I\left(\left|\underline{\alpha}\right|\right) f(F)$. We choose the interval $I\left(\left|\underline{\alpha}\right|\right)$ containing $\left|\underline{\alpha}\right|$ in such a manner that the set $I\left(\left|\underline{\alpha}\right|\right) f(F)$ consists of one and only one point $\left|\underline{\alpha}\right|$. Hence the power of the set $I\left(\left|\underline{\alpha}\right|\right) f(F) < \aleph_0$, and the power of the set $I(x_0)F > \aleph_0$. The function $f(x)$ is regular in F, therefore the set Q of all the points $f(x)$ where $x \in I(x_0)F$ has also a power $> \aleph_0$, which is impossible because $Q \subset I\left(\left|\underline{\alpha}\right|\right) f(F)$.

It is clear that every function $y = f(x)$ expressing the biunivocal correspondence $E_1 \leftrightarrow E_2$ between the sets E_1 and E_2, is a function of the class (Z), consequently, $f(x)$ is hypermeasurable (I).

Received
6.XI.1943.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

PHYSICS

ABILITY OF CRYSTALLINE QUARTZ AND OF GLASS MELTED FROM IT TO TAKE COLOUR ON IRRADIATION

By G. G. LAEMMLEIN

(Communicated by S.I. Wawilow, Member of the Academy, 14. II. 1944)

Two hypotheses have been put forward to account for the nature of the smoky colour in crystalline quartz (1). According to one of them, quartz by analogy with halides is coloured by the colloidal particles of atomic silicon knocked out of the lattice of quartz by active radiation. On the other hypothesis, the appearance of colour is not possible without the presence of an admixture captured by the quartz during its growth. Yet colour is only one of the apparent manifestations of different properties inherent in coloured as well as uncoloured crystals. A number of other optical properties and phenomena, such as the refraction index, different phenomena of luminescence, as well as certain physical and chemical qualities of the crystal, *e. g.* the rate of solution, electrical properties, mechanical properties of the lattice, *etc.* (2, 3) have also been found to have a definite relation to colour. For a final solution of the problem one has to carry out a complex investigation aimed to reveal the correlation between the above-mentioned properties of a crystal, and taking account of the complicated situation created by the natural conditions that have influenced the formation of the crystal and its subsequent history. In my opinion the smoky colour of quartz may be explained in the following way. A pure quartz is colourless ideochromatically, and no hard radiation can induce it to take colour unless the crystal contains a microscopic quantity of foreign admixture. Under natural conditions the growth of crystals is bound to proceed in a polycomponent system and, however pure a crystal may appear, there is always a certain amount of microcomponents of the system contained in it. The admixture is in equilibrium with the lattice of the host crystal, forming in it potential centres of coloration. The crystal remains colourless until these centres have changed their state under the action of a short-wave radiation (which appears to cause ionization) and become centres of colouring.

For the time being one may only surmise that the admixture sensibilizing the lattice consists in bivalent ions of iron, while trivalent ions of iron constitute the admixture responsible for the pigmentation. Upon the content of the sensibilizing admixture depends the density of the smoky colour acquired by the crystal on irradiation. Under natural conditions the colour of a crystal which was initially colourless but afterwards sensibilized, becomes apparent only if the crystal during its growth has taken up some active admixture along with the sensibilizing one. This interpretation has found substantial confirmation in experiment and observations, but some of its links are still waiting for a more conclusive evidence.

It is a matter for regret that the quantities of sensibilizing and active admixtures sufficient for colouring the crystalline lattice of quartz may be so small, as to defy detection by the most subtle analytical methods. Moreover, a gross analysis cannot possibly reveal the agents directly responsible for the coloration.

One of the methods to prove that this sensibilization of the crystalline lattice may, or may not be caused by admixtures is the investigation of glasses obtained from the crystals by fusion. In order to establish whether the potential centres of coloration in the lattice of crystalline quartz are a foreign admixture, or, as is believed by some workers, are only weak points of the lattice itself, I under-

took several experiments in which glasses fused from different varieties of quartz were subjected to irradiation. Pure crystalline quartz is softened and fused at 1700° C to form a glass which is colourless, irrespective of the fact whether the crystal possessed a colour or not. The colourless quartz glass when exposed to the action of radium or X-rays takes usually on a violet, rarely a greyish-brown colour. According to O. Wild [4], a glass made from crystals of yellow quartz (citrine) turns green in this case.

There exists an opinion, which has no reliable foundation, however, that the colouring of the quartz glass by irradiation (just as in the case of crystalline quartz) is due to the elimination of elementary silicon from the lattice [5]. Hoffman [6] who has spent much time on studying the coloration of quartz glasses claims that the colour in the crystalline quartz, as well as in glasses, is caused by ferro-ferri ions which may possibly act in combination with Ti_2O_3 and other oxides, but not with manganese. Upon heating, quartz glasses coloured by irradiation lose colour and are emitting a bright violet pyroluminescence.

The fusion of crystalline quartz was carried out in the laboratory of the Moscow Electric Lamp Works in a pure oxyhydrogen flame. From the glass drops rods, 3 to 4 mm in diameter, were drawn. The samples of the quartz contained no visible inclusion. Their colouring was effected by irradiation with a Coolidge tube at $I=8$ mA, at a distance of 20 cm from the target, without special cooling.

Subjected to fusing and irradiation were: 1) a piece of a colourless crystal from an Alpine type of vein, Mt. Sura-iz (Polar Urals), which had scarcely taken any colour on control irradiation. The glass made from it took no colour either, or nearly so, even after 400 mA hours of irradiation; 2) a piece of quartz of light smoky colour also from Alpine veins, Mt. Ner-oyka (Polar Urals); glass made from this crystal acquired a faint violet colour; 3) a piece of dark-coloured smoky quartz (morion from the pegmatites of Pisarevka (Ukraine); the glass made from it displayed an intense violet colour as soon as after 7 mA hours, and became almost transparent after 300 mA hours; 4) colourless crystal from quartz veins of Barnovadge (Pamir), in which the control irradiation had produced a zonal smoky colour alternating with yellowish citrine layers; the glass from this crystal readily took an ordinary violet colour; 5) a piece of weakly coloured ametist from pegmatites of Murzinka (Urals); it received an additional faint smoky colour on control irradiation; the glass from this crystal took a weak greyish-violet colour.

It will be obvious that specimens of crystalline quartz of different origin, as well as the glasses made from them show a wide range of gradations in their ability to take colour. It may be inferred from this that both in the lattice of the crystalline quartz and in the quartz glass the potential centres of coloration are formed by a foreign admixture of SiO_2.

As the quartz glass used in certain kinds of illumination engineering apparatus has to meet very high technical requirements, one is compelled to search for special varieties of crystalline quartz and for convenient criteria for their determination.

It is possible that the ability or inability of a quartz glass to take colour may be definitely related to its different properties, such as crystobalitization, transparency to the ultra-violet, and so on. This circumstance may be turned to account in testing the suitability of quartz crystalline raw material for fusion. It is all the more convenient, as the quartz crystals that take colour are, according to the unpublished data of N. E. Vedeneeva and the author, easily distinguishable from those which do not, by their ability to emit cathode luminescence.

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Received
14.II.1944.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

PHYSICS

STRONG CURRENTS THROUGH ELECTROLYTE OBTAINED BY MEANS OF GAS DISCHARGE UNDER ATMOSPHERIC PRESSURE

By V. I. PAVLOV

(Communicated by A. F. Joffe, Member of the Academy, 13. XII. 1943)

The possibility of carrying out electrolysis without electrodes has been under discussion for a long time, and it was Faraday himself who raised this problem.

As a result of numerous investigations (1) the use of the Geissler discharge as a cathode has been developed for aqueous conducting solutions. The discharge took place under a pressure of the order of 1 mm in water-vapour over a solution placed in a cooling mixture and subjected to a continuous action of an evacuating pump. In that way currents through the electrolyte could be obtained of an order of tenth fractions of an ampere from a constant potential difference of several hundred volt.

This kind of experimental set-up has been the most widespread up to the present (2). Somewhat different is the scheme of Pissarjevsky (3), in which a spark from an induction coil in the air at atmospheric pressure is used as gas electrode.

In order to create a certain initial number of ions in the gas under atmospheric pressure, the air adjoining the surface of the electrolyte was ionized by means of a strong preparation of RaTh. And for increasing the number of ions I employed, following Pissarjevsky, the mechanism of secondary ionization in the spark. A constant ionization of the gas has the advantage of reducing the spark potential difference between the plane surface of the electrolyte and the pointed electrode. Using for the electrode a metal disc, 6 cm in radius, having on its surface turned to the liquid 30 pointed ends, all carefully sharpened and levelled, it was possible to obtain a rectified current through the electrolyte of about tenth fractions of an ampere, the potential difference on the terminals of the secondary winding of the transformer being of the order of a thousand volt. The number of simultaneously working sparks did not exceed 10, and these sparks passed in an uncontrolable way from one pointed electrode to another. One spark could attain several millimeters in length. The ionization was effected from the inner surface of a metallic band which descended as a belt from the lateral surface of the disc.

Thus, the problem of the use of a sufficiently large and accurately controlled quantity of gas ions for any gas in the process of current transfer through a conducting solution in any solvent can be studied experimentally in its various aspects. It may also be noted here that, according to preliminary data obtained by me, the physical picture of electrolysis with a gas electrode is by far more complicated compared to the simple transfer of the charge by ions at the surface of the liquid, and is connected with a number of physical-chemical phenomena caused by the penetration of some foreign active agents (gas ions) into a system composed of various known molecular species which under ordinary conditions are in a state of chemical equilibrium.

Kazan Chemical-Technological Institute.

Received 20.I.1944.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

TECHNICAL PHYSICS

A DEVICE ATTACHED TO OPTICAL PYROMETER OF DISAPPEARING FILAMENT TYPE TO EXTEND ITS SCALE OVER LOW TEMPERATURES

By S. I. FREIVERT

(Communicated by S. I. Wawilow, Member of the Academy, 8. I. 1944)

Among the advantages offered by the use of optical methods in measuring the temperature is the fact that the measuring apparatus is not in contact with the heated body. In fact, there are cases where any other but optical methods are out of the question, because the measuring instrument — a thermocouple, for instance, cannot be brought for some reason or another into contact with the body whose temperature is to be measured, the latter being either beyond reach, or *in vacuo*, or prone to affect the measuring instrument chemically (as in the case of molten metal). However, the optical pyrometers with disappearing filament, which are

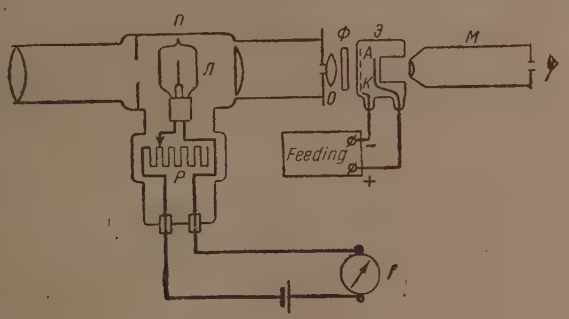

Fig. 1

lhe most widespread at present, are not fitted to measure the temperature betow 650—700° C. At the same time, in practical work one is often faced with the necessity of measuring lower temperatures under conditions that preclude the use of thermoelectric methods for the above-mentioned reasons.

It would seem therefore that much may be gained by extending the scale of the disappearing filament pyrometer over lower temperatures.

Intended to serve this purpose is the device represented in Fig. 1, which has been designed by the author as a supplement to the optical pyrometer.

The electric lamp of an ordinary optical pyrometer has its filament lying in the plane of the image of the heated surface whose temperature is to be measured. The filament is projected in infra-red rays upon the surface of the photo-cathode K of an electrono-optical transformer ([1]) $\Im$ (Holst's tube) by means of a short-focus lens O placed behind the exit pupil of the pyrometer. This infra-red image is transferred by electrons moving in an accelerating electric field into a luminescent screen A to become there a visible image which is viewed through a low-power microscope M or a magnifying glass. A black glass filter Φ placed before the cathode K

serves to separate a more of less narrow portion of the infra-red region of the spectrum and to absorb the scattered visible light passing through the pyrometer. In taking measurements, one proceeds in the same way as in the case of visible light.

The intrinsic brightness of the filament of the lamp J is controlled with the aid of rheostat P and may be adjusted to make the image of the filament disappear

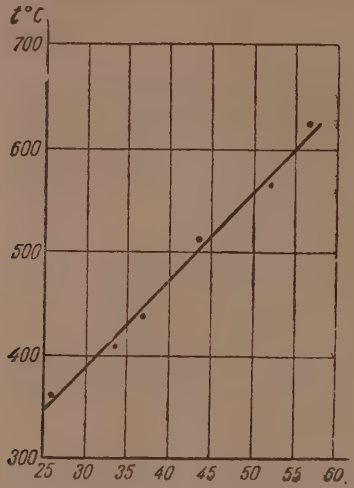

Fig. 2

against the background of the image of the heated surface. Then a galvanometer previously calibrated for temperature is read. Calibration of the pyrometer by exposure to a black body gives the curve shown in Fig. 2. From this plot it may be seen that by means of the proposed device temperatures up to 350° C can be measured within ±10—12° C.

The device can be attached to the eye-piece of an ordinary optical pyrometer.

To conclude, it may be remarked that an optical pyrometer provided with this attachment can be employed for controlling temperature in the thermal treatment of metals (tempering, rolling) and in glass industry.

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Received 8.I.1944.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

GEOPHYSICS

ON A MODE OF AREAL SEISMIC PROSPECTING BY THE CORRELATION REFRACTION METHOD

By G. A. GAMBURZEV

(Communicated by O. J. Schmidt, Member of the Academy, 20. XII. 1943)

At the first stage of the development of the refraction prospecting the question was raised as to a kind of areal seismic survey method based upon «isotime maps», *i. e.* such maps in which equal travel time curves of seismic waves generated at a single shot-point are plotted. But the defects inherent in the old modification of the refraction method («first arrival times» method) presented serious obstacles for the proper construction and use of isotime maps. In the first place there was: a) the difficulty, and at times impossibility, to fix the zones where one type of wave is being replaced by another type; b) the fact that it was impossible in principle to discriminate between waves refracted at different boundaries in case they had been generated by a single shot and observed on the same area.

The former circumstance often leads to an isotime map being referred to one definite wave and, accordingly, to one boundary, whereas in its different sections this map ought to be referred to different waves and, hence, to different boundaries. Owing to this, one was liable to err grossly in interpreting the observations.

The latter factor impeded the prospecting of a many-layer medium considerably, enlarging the amount of field work and making the interpretation a complicated affair. And many other important shortcomings of the «first arrival times» method might be pointed out in relation to the areal prospecting dealt with in this note.

The introduction of the correlation refraction method (CRM) (1) has largely relieved the «isotime» method of the defects mentioned above, and has opened for it some new prospects.

The first attempt of applying the «isotime» method to the prospecting by the CRM was made in 1942 by the Geophysical staff of the Volga-Bashkirian Oil-Prospecting Expedition of the Academy of Sciences of the USSR, when exploring the zone of the Pokrovsky gravity maximum in the Ishimbay region. A second attempt was made in 1943 by the same expedition, this time in collaboration with the Central Scientific Laboratory of the Geophysical Trust of the People's Commissariat for Oil Industry, when exploring the area of the Karagan buried limestone massif within the same region. The results of the observations went to confirm the value of the «isotime» method and led to a number of important conclusions. In what follows those of them are discussed which in point of method are of general significance for areal seismic survey by means of the «isotime» modification of CRM.

1. The CRM offers several criteria which make it possible to judge of the regularity of the wave correlation. Such are the shape and intensity of the vibrations, as well as the geometrical characteristics based upon a comparative study of the shape of the travel time curves (for example, the parallel run of «overtaken» time curves).

Unlike profile prospecting, areal prospecting permits the correlation regularity to be controlled according to a new sign. In the case of areal prospecting, the refracted waves may be traced along closed line systems (with the shot-point in constant position). Following the line of correlation and returning to the initial point, we must arrive at the initial phase, unless the correlation happened to be disturbed on the way. Experience has shown that this procedure serves as a rigorous control of the regularity of correlation. This is one of the main advantages of areal prospecting over profile prospecting when the CRM is used. As to the advantages of the CRM in areal prospecting compared to the method of «first arrival times», they become quite obvious if we take into account that one using the latter is benefited by none of the correlation signs mentioned here (save the geometrical ones). Thus, the application of the CRM in its «isotime» modification eliminates most of the errors which are due to the confusion of waves of different origin and whose part in the method of «first arrival times» was an obviously negative one, as pointed out in (a).

2. The correlation signs listed in the foregoing section make it possible to separate on the research surface such regions within which the wave type remains constant. These regions may be superimposed upon one another (entirely or partly) or else may be separated by an intermediate zone. The boundaries of these regions may differ as to their physical significance. In some cases they may serve as contour lines of the correlation region for waves of a definite type (but in general not as boundaries of their existence). We shall have to do with boundaries of this kind, for example, in the case where the wave traced by us will be superimposed by another, more intense one. The former may possibly subsist outside the correlation region, but the complexity of the interference picture will prevent its being identified and studied. In other cases the wave to be traced becomes, as it approaches a definite zone, less intense than the rest of vibrations, and, finally, ceases to be practically perceivable in a given zone. In a number of cases the changes in amplitude are so abrupt that they can be spoken of as ruptures of the wave or of the phase, and, accordingly, as a boundary of the wave existence region. Phenomena of this kind are often related to certain peculiarities proper to the structure of seismic boundaries, say, to a sharp change in the angle of dip, to the wedging of the refracting layer, *etc.*

Refraining in this note from a more detailed classification of the boundary lines (or zones) of wave regions, let us point out the part played by them when prospecting by the CRM.

From the experience of profile seismic prospecting by the CRM it could be inferred that, save some quite explicit cases, ruptures of correlation are but a hindrance in prospecting. Our experience in areal prospecting makes us, however, abandon this view.

First, it has been shown that, unlike the profile prospecting, the areal one permits to get rid of some kinds of correlation rupture, occupying a strictly defined area. Among these belong, for example, such ruptures as are due to the heterogeneity of the weathered layer. By eliminating these seismic anomalies of «casual» origin, the main regularities of the seismic field, connected with the most essential characters of the geological structure, can be fixed in a more explicit shape with the least distortion possible.

Secondly, the analysis of the causes responsible for the rupture of correlation and wave types is facilitated by the new method; the study of the geometry of wave existence regions and of their boundary lines is greatly helpful here. A number of simple examples can be cited to illustrate this statement.

Lastly, of paramount importance is the fact that the boundary lines of wave existence regions have a definite physical-geological significance, the shape and position of the boundary lines being closely connected with the features of a given geological structure.

The most clear-cut results are obtained in the case where at the boundary of the region there is a rupture of the phase, caused by a rupture of the refraction surface. In this case the projection of the marginal zone of the refracting boundary on

the research surface can be retraced, and this may be of high geological interest for some districts.

A number of other new problems might be listed here, to which qualitative methods of seismic survey are applicable.

3. The practical possibility is proved of mapping for the same area, and with explosions caused at the same point, several isotime maps referring to several refracting boundaries. Prospecting, as well as both quantitative and qualitative interpretation of observations in the case of a many-layered medium, is thereby considerably facilitated. In many a case a qualitative comparison between the isotime maps is sufficient to answer the question as to the geological boundaries responsible for the seismic anomalies plotted on a definite map. The boundary lines of wave existence may be given a clearer geological interpretation. A quantitative interpretation of the isotime maps makes it possible to plot maps of refracting boundaries in isodepths, allowance being made for the three-dimensional nature of the problem.

In concluding it should be noted that no areal prospecting based on the «isotime» method can be practised unless combined with other types of seismic prospecting. It should at least be supplemented with observations carried out along «calibrating» longitudinal profiles, made with the aim of deciphering the phases and of studying the velocity distribution of the media. It may also prove necessary to supplement it with an additional network of longitudinal profiles for determining the configuration of boundaries in the proximity of the research surface.

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Received
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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

GEOPHYSICS

ON THE USE OF GRAVITATIONAL SURVEY DATA OF RECONNOITRING NATURE

By E. N. LUSTIKH

(Communicated by O. J. Schmidt, Member of the Academy, 19. XII. 1943)

It sometimes happens in the practice of gravimetric prospecting that a complete quantitative interpretation of the survey data is impossible because of their insufficient accuracy and density. In most of such cases, however, one may still with reasonable certainty derive quantitative relations concerning the position of anomalous masses. Not seldom, for instance, one can compute the limiting depth of the layer responsible for the anomaly, whereby I mean the level, respecting which it may be said beforehand that at least a portion of the roof of the layer lies above it. Fisher (1) gives a formula for calculating the limiting depth from the extreme value of the third derivative of the gravity potential $\frac{\partial^3 V}{\partial x^2 \partial z}$. In certain cases where it is possible to set up additional conditions, the relation between the first and second derivatives can be used for the same purpose.

Let us consider the problem in two dimensions. Place the origin of a rectangular system of coordinates on the surface of the Earth. Take the Z axis to be directed vertically downwards and the X axis to run horizontally across the strike of the anomalous body.

Suppose that there is only one surface of division between the masses of density D_1 lying above it and those of density D_2 lying below; that the depth z of this interface is confined within $h \leqslant z \leqslant H$. The form of the interface in the interval from x_1 to x_2 is assumed to be unknown, but it is known that to the one side of this interval $z = h$ everywhere, and to the other $z = H$. Then with increasing distance from this interval the anomaly of gravity $\frac{\partial V}{\partial z}$ asymptotically approaches the limits g_1 and g_2. If it it possible to establish from the survey data that

$$|g_1 - g_2| \leqslant \Delta g$$

Δg being a definite value, and that the maximum absolute value of the horizontal gradient of gravity is not below a certain value G

$$\left|\frac{\partial^2 V}{\partial x \partial z}\right|_{\max} \geqslant G$$

then one may find the limiting depth of the position of the layer. It may easily be shown that under the above-mentioned restrictions the greatest depth of the roof (*i. e.* of the surface $z = h$) corresponds to vertical fault. Adopting the notation $\Delta D = |D_1 - D_2|$, and denoting by f the gravitational con-

stant, we obtain for the limiting depth the expression

$$h \leqslant \frac{\Delta g}{2\pi f \Delta D\left(\exp \frac{G}{2f\Delta D} - 1\right)} \qquad (1)$$

If the density difference ΔD is unknown, the calculation for an infinitely thin half-plane gives a rougher limit

$$h < \frac{\Delta g}{\pi G} \qquad (2)$$

The formulae (1) and (2) were used in analysing the gravitational field in several areas of the Ishimbay Urals. In one case such calculations have led to the conclusion that the roof of Kungurian rocks does not lie below 100 m from the surface, whereas the borings made in a neighbouring region seemed to have made it clear that the depth of the Kungurian roof cannot possibly be smaller than 200 m. Later, however, seismological investigations fully confirmed the conclusions derived from the gravimetrical survey, since it was found that in the region of the gravitational «step» the Kungurian rocks are lifted to a level of 75 m from the Earth surface.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

GEOPHYSICS

CONTRIBUTION TO THE THEORY OF SECCI DISC

By B. V. OVCHINSKY

(Communicated by O. J. Schmidt, Member of the Academy, 20. XII. 1943)

The relation between the depth at which a Secci disc is becoming invisible and the optical constants of the water has been more than once discussed by workers in sea optics.

For a purely scattering medium the empiric formula derived by W. Shoulejkin (1) from observations is $z = \frac{0.15}{a}$, where a is the modulus of scattering ($\sigma_\lambda = a/\lambda^4$); z is the depth at which the disc disappears. A. Gershun (2) recommends the use of an empiric rule, according to which the extinction coefficient multiplied by the «disappearance» depth value is equal to 8 ($zc_\lambda = 8$).

Our object is to make use of the theory of none-horizontal visibility, which has recently been developed by E. Kuznetzov (3) in connexion with the problems of atmospheric optics. In this theory approximate equations for a purely scattering medium are established which link up the depth of disappearance of the disc with the coefficient of scattering. The problem is solved on the following assumptions.

1. Uniformity of scattering (spherical indicatrix of scattering).
2. Invariability of the scattering coefficient with depth.
3. The light falling on the sea surface is supposed to be a diffused light.

The dimensions of the disc are assumed to be small in comparison with the depth of disappearance. For simplicity sake the albedo of the bottom is put at zero. The brightness contrast k will be understood to mean the absolute value of the difference between two brightnesses referred to the larger of them. Under these conditions $0 \leqslant k \leqslant 1$.

Upon the above-mentioned assumptions the equation for the transfer of radiation may be written as follows (3):

$$\left.\begin{aligned} -\cos\theta \frac{\partial I_\lambda^{(1)}(\tau, \theta)}{\partial \tau} &= J(\tau) - I_\lambda^{(1)}(\tau, \theta) \\ \cos\theta \frac{\partial I_\lambda^{(2)}(\tau, \theta)}{\partial \tau} &= J(\tau) - I_\lambda^{(2)}(\tau, \theta) \\ J(\tau) &= \frac{\sigma_\lambda}{2c_\lambda} \int_0^{\frac{\pi}{2}} I_\lambda^{(1)}(\tau, \theta) \sin\theta d\theta + \frac{\sigma_\lambda}{2c_\lambda} \int_0^{\frac{\pi}{2}} I_\lambda^{(2)}(\tau, \theta) \sin\theta d\theta \end{aligned}\right\} \quad (1)$$

where $\tau = \int_0^z c_\lambda \rho(z)\, dz$; $\rho(z)$ is the density of water at a depth z; $I_\lambda^{(1)}(\tau, \theta)$,

$I_\lambda^{(2)}(\tau, \theta)$, the brightness of the issuing and entering light at depth τ and angle θ formed by the vertical with the direction of the ray. The system of coordinates is so chosen that $\tau = 0$ at the surface of the sea and $\tau = \tau^*$ at the bottom. The boundary conditions are given in the form

$$I_\lambda^{(1)}(\tau^*, \theta) = 0, \quad I_\lambda^{(2)}(0, \theta) = I_\lambda^{(s)} \tag{2}$$

Under the boundary conditions (2) the equation (1) may be written thus:

$$I_\lambda^{(1)}(\tau, \theta) = \sec\theta \int_\tau^{\tau^*} J(t)\, e^{-(t-\tau)\sec\theta}\, dt \tag{3}$$

$$I_\lambda^{(2)}(\tau, \theta) = I_\lambda^{(s)} e^{-\tau\sec\theta} + \sec\theta \int_0^{\tau} J(t)\, e^{-(\tau-t)\sec\theta}\, dt \tag{4}$$

Let us construct the expression for the contrast k. For this to be done we have to establish:

a) The brightness of the background from formula (3)

$$I_\lambda^{(1)}(\tau_0, \theta) = \sec\theta \int_{\tau_0}^{\tau^*} J(t)\, e^{-(t-\tau_0)\sec\theta}\, dt \tag{5}$$

b) The apparent brightness of the screen

$$\widetilde{I}_\lambda^{(e)}(\tau_0, \theta) = e^{-(\tau_e-\tau_0)\sec\theta} I_\lambda^{(e)}(\tau_e, \theta) + \sec\theta \int_{\tau_0}^{\tau_e} J(t)\, e^{-(t-\tau_0)\sec\theta}\, dt \tag{6}$$

where $\tau_0 < \tau_e$ is depth at which the observer and disc are located; $I_\lambda^{(e)}(\tau, \theta)$ is the brightness of the disc.

In determining $I_\lambda^{(e)}(\tau_e, \theta)$ we have to bear in mind that

$$F_\lambda^{(1)}(\tau_e) = q_\lambda^{(e)} F_\lambda^{(2)}(\tau_e) \tag{7}$$

where $F_\lambda^{(1)}(\tau_e)$ and $F_\lambda^{(2)}(\tau_e)$ is the flux of light moving upwards and downwards, respectively, and $q_\lambda^{(e)}$ is the albedo of the disc. To simplify we assume that the disc gives a diffuse reflection of light, *i.e.* $F_\lambda^{(1)}(\tau_e) = \pi I_\lambda^{(e)}(\tau_e, \theta)$. $F_\lambda^{(2)}(\tau_e)$ may be calculated simply from formula (4). By means of formula (7) one may easily establish the expression for the screen brightness

$$I_\lambda^{(e)}(\tau_e, \theta) = 2q_\lambda^{(e)}\left[H_3(\tau_e)\, I_\lambda^{(s)} + \int_0^{\tau_e} J(t)\, H_2(\tau_e - t)\, dt \right] \tag{8}$$

where $H_n(x) = \int_1^\infty \frac{e^{-xs}}{s^n}\, ds$ is Gold's function of order n, well-known in meteorology.

By means of formulae (5), (6) and (8) we can write the expression for the contrast:

$$k = \frac{2q_\lambda^{(e)} e^{-(\tau_e-\tau_0)\sec\theta} \cos\theta \left[I_\lambda^{(s)} H_3(\tau_e) + \int_0^{\tau_e} J(t)\, H_2(\tau_e - t)\, dt \right] - \int_{\tau_e}^{\tau^*} J(t)\, e^{-(t-\tau_0)\sec\theta}\, dt}{2q_\lambda^{(e)} e^{-(\tau_e-\tau_0)\sec\theta} \cos\theta \left[I_\lambda^{(s)} H_3(\tau_e) + \int_0^{\tau_e} J(t)\, H_2(\tau_e - t)\, dt \right] + \int_{\tau_0}^{\tau_e} J(t)\, e^{-(t-\tau_0)\sec\theta}\, dt}$$

or

$$k = \frac{\int_{\tau_e}^{\tau^*} J(t)\, e^{-(t-\tau_0)\sec\theta}\, dt - 2q_\lambda^{(e)} \cos\theta\, e^{-(\tau_e-\tau_0)\sec\theta} \left[I_\lambda^{(s)} H_3(\tau_e) + \int_0^{\tau_e} J(t)\, H_2(\tau_e - t)\, dt \right]}{\int_{\tau_0}^{\tau^*} J(t)\, e^{-(t-\tau_0)\sec\theta}\, dt} \tag{9}$$

Thus, for finding the contrast k one must have $J(t)$. Substituting in the last equation of the system (1) the values obtained from (3) and (4), one arrives at an integral equation for $J(\tau)$:

$$J(\tau) = I_\lambda^{(s)} \frac{\sigma_\lambda}{2c_\lambda} H_2(\tau) + \frac{\sigma_\lambda}{2c_\lambda} \int_0^{\tau_0} J(t) H_1(|\tau - t|)\, dt \qquad (10)$$

This kind of equation is dealt with in detail by Kuznetzov (3). In this paper we make use of the approximate method applied by Schwarzschild and Miln in solving some problems of astrophysics (4). This method essentially consists

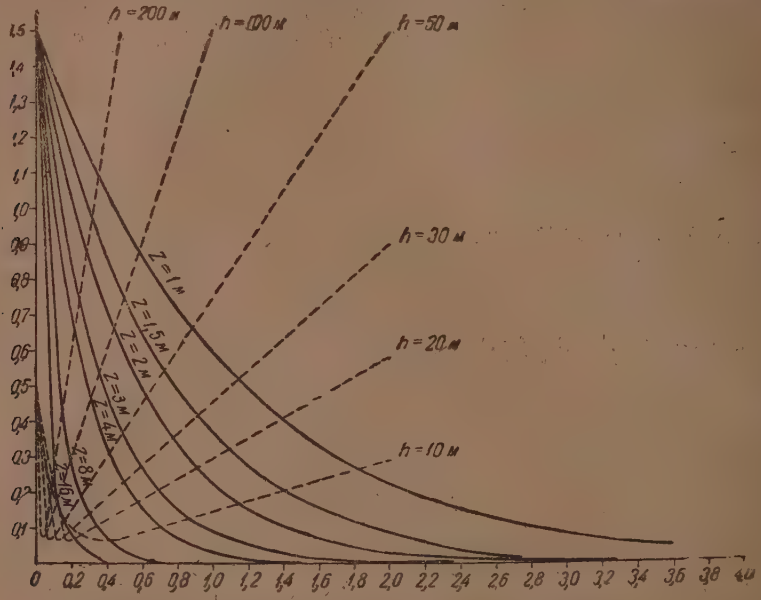

Fig. 1. Nomogram for determining the scattering coefficient σ_λ for $\theta = 0°$

in averaging $\cos\theta$ in equation (1) (it is supposed that $\cos\theta = {}^1/_2$). On this basis the following approximate equation can be established for a purely scattering medium (5):

$$J(\tau) \approx \frac{1}{2\pi} [F_\lambda^{(1)}(\tau) + F_\lambda^{(2)}(\tau)] = \frac{I_\lambda^{(s)}}{\tau^* + 1} [\tau^* + {}^1/_2 - \tau] \qquad (11)$$

Replacing in the first expression (9) $J(\tau)$ by its value from (11) and putting $k = \varepsilon$ (the threshold of contrast sensitivity), we arrive at an equation connecting σ_λ and z:

$$e^{-\sigma_\lambda z \sec\theta} [H_3(\sigma_\lambda z) - 2H_4(\sigma_\lambda z) + {}^2/_3 + \cos\theta] = \\ = \varepsilon h \sigma_\lambda + \varepsilon ({}^1/_2 - \cos\theta) - ({}^1/_2 - \cos\theta)\, e^{-h \sec\theta} \qquad (12)$$

It has also been supposed that $q_\lambda^{(e)} = 1$; $\tau_0 = 0$ (the observer is at the water surface); $\tau_e = \sigma_\lambda z$ and $\tau^* = \sigma_\lambda h$ (h is the depth of the reservoir).

For solving the equation (12) a nomogram for $\theta = 0°$ ($\varepsilon = 1.5$ per cent) is plotted (Fig. 1). A family of curves corresponding to the left side of equation (12) is drawn, considering σ_λ as an independent variable and z as a given parameter. Analogous constructions are made for the right-hand side of the equation (12), taking h for parameter. The abscissa of the intersection point gives the sought-for value of σ_λ. By means of the equation (12) one may com-

pute the distance at which the disc when illuminated by rays of different wave-length is still visible. While performing this operation, we assigned such values to the scattering coefficients as are typical, according to Lagrand ([2]) for the open sea. The results of computation are represented in Fig. 2. The graph gives an idea as to the influence of the colour of illumination on the visibility distance.

The case of an infinitely deep sea needs special consideration. In this case ($\tau^* \to \infty$) it may be easily established ([5]) that $F_\lambda^{(1)}(\tau) = F_\lambda^{(2)}(\tau) = \pi I_\lambda^{(s)}$, hence $J(\tau) = I_\lambda^{(s)}$. To the same result one arrives by considering the exact solution of equation (10) when $\sigma_\lambda = c_\lambda$. The form of this solution may be represented as $J(\tau) = I_\lambda^{(s)} + cB(\tau)$, where $B(\tau)$ is in its turn the solution of the homogeneous integral equation

$$B(\tau) = \frac{1}{2} \int_0^\infty B(|t|) H_1(|\tau - t|)\, dt.$$

This equation is known to have a solution different from zero. The convergence of successive approximation is proved and the linear boundary establi-

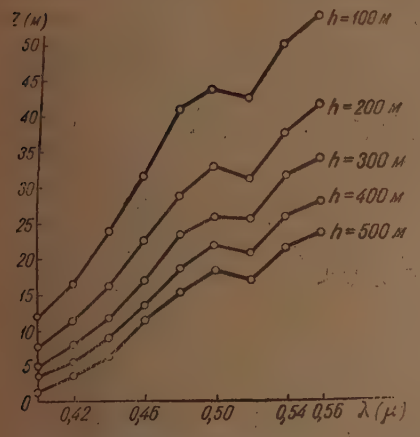

Fig. 2. Depth of disappearance of the disc for different depths of the reservoir at $\theta = 0°$

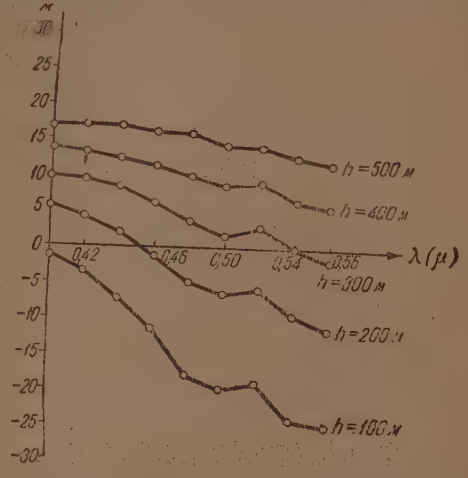

Fig. 3. Difference in visibility distance for observers placed in the water and at the surface

shed within which the solution of the equation is included. But if we assume that $J(\tau) = I_\lambda^{(s)} + cB(\tau)$, we shall find that the light flux should increase unboundedly with depth. It remains to suppose that $c = 0$ and $J(\tau) = I_\lambda^{(s)}$. This corresponds to the invariability of the luminous flux with depth. If $J(\tau)$ in the second equation of (9) is substituted with $I_\lambda^{(s)}$ and it is assumed that $k = \varepsilon$, one arrives at the following equation:

$$z \sec \theta = \frac{1}{\sigma_\lambda} \ln \frac{1 - q_\lambda^{(e)}}{\varepsilon} \qquad (13)$$

putting $\tau_e = \sigma_\lambda z$ and $\tau_0 = 0$.

Formula (13) approaches in form to the formula suggested by Koschmieder.

Suppose now that the observer is located below the disc at a certain depth τ_0 and the position of the disc is at a depth τ_e, $\tau_e < \tau_0$. Let us establish a formula for determining the visual range, analogous to (12). For that purpose we shall have to determine the brightness of the background and the apparent brightness of the screen, to construct the expression for the contrast

and equate k to ε. We shall then obtain

$$2\,[2H_4(\sigma_\lambda h)-H_3(\sigma_\lambda h)+{}^1/_3+\sigma_\lambda z]\,(1-\varepsilon)\,e^{-\sigma_\lambda z}+e^{-\sigma_\lambda z}+2\sigma_\lambda z=4+\varepsilon\,(2h\sigma_\lambda-1) \quad (14)$$

It is assumed that $\tau_e=0$ (the disc is at the surface).

Equation (14) has been solved graphically. We have obtained the values of the visual range when the observer is in the water, and the disc at sea level. In Fig. 3 differences are given between the visual range for observers placed in the water and at the surface.

From this it may be seen that the difference may be positive as well as negative. The decisive point in this treatment of the problem is the depth of the reservoir. In a reservoir of sufficient depth the visual range for an observer placed in water is higher than for one placed at the surface.

In conclusion I wish to express my gratitude to Prof. E. S. Kuznetzov for many a valuable suggestion made in the course of this work.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

CHEMISTRY

CONVERSION OF NATURAL BORATES INTO BORIC ACID AND FERTILIZERS BY THE PROCESS OF PHOSPHATE TREATMENT

By S. I. WOLFKOVICH, Corresponding Member of the Academy,
and L. E. BERLIN

The authors have suggested the use of phosphoric acid for the decomposition of natural borates of magnesium, calcium and sodium, by means of which boric acid is obtained. Their aim has been to turn phosphoric acid to account in two ways: 1) its energy was to be utilized for the decomposition of the borate, and 2) the acid itself made a constituent part of a fertilizer which is a by-product of this process and contains the phosphates of magnesium, calcium and sodium with an admixture of boric acid and its salts. In order to remove free acidity from the fertilizer, the mother liquor or slime is neutralized by lime or ammonia (the use of phosphate is possible) and transformed into a solid product.

So this method is intended to make full use of both the borate and the phosphoric acid.

The decomposition of borates by the sulphate method now in use, or by the nitrate method proposed some time ago have not yet been developed to a stage where all components of the raw material could be utilized to full extent, though work towards this goal is in progress ([1], [2]).

The fertilizer obtained by the phosphate method contains three nutrient elements: phosphorus, boron and magnesium.

The main reactions taking place on the decomposition of the asharite rocks (composing the basic mass of the rich borates of Inder) can be described by the following equations:

$$2MgO \cdot P_2O_3 \cdot H_2O + 4H_3PO_4 + aq = 2MgH_4P_2O_8 + 2H_3PO_3 + aq \quad (1)$$

$$(Ca, Mg)\,CO_3 + 2H_3PO_4 + aq = (Ca, Mg)\,H_4P_2O_8 + aq \quad (2)$$

$$(Al, Fe)_2O_3 + 2H_3PO_4 + aq = 2(Al, Fe)\,PO_4 + aq \quad (3)$$

Acid phosphates of iron and aluminium could only form in insignificant quantities under conditions of our experiment, since H_3PO_4 was not applied in excess against the norms set up by the equations (1), (2) and (3). For a better crystallization of H_3BO_3 the solutions should have a slight free acidity. If reduced norms of H_3PO_4, as compared to those of the equation (1), are used, one will obtain calcium and magnesium phosphates (Mg, Ca) HPO_4, insoluble in water but soluble in a citrate ammonia solution. The use of H_3PO_4 in a notably excessive proportion with subsequent neutralization of the surplus is of practical interest in case the ratio of P_2O_5 to B_2O_3 in the fertilizer should be increased on agrochemical considerations.

As a result of the reactions (1), (2) and (3) H_3BO_3, $CaH_4(PO_4)_2$ and $MgH_4(PO_4)_2$ go over into solution. Upon the filtration of the residue the solution is cooled down to 15° C, whereby the boric acid is crystallized and is then filtered off. The resulting mother liquor is neutralized by lime or ammonia, according to the following

reactions:

$$MgH_4P_2O_8 + CaCO_3 + aq = MgHPO_4 + CaHPO_4 + CO_2 + aq \quad (4)$$

$$CaH_4P_2O_8 + CaCO_3 + aq = 2CaHPO_4 + CO_2 + aq \quad (5)$$

$$H_3PO_4 + CaCO_3 + aq = CaHPO_4 + CO_2 + aq \quad (6)$$

or

$$HgM_4P_2O_8 + 3NH_3 + aq = MgH_4PO_4 + (NH_4)_2\,HPO_4 + aq \quad (7)$$

$$CaH_4P_2O_8 + 2NH_3 + aq = CaHPO_4 + (NH_4)_2\,HPO_4 + aq \quad (8)$$

$$H_3PO_4 + 2NH_3 + aq = (NH_4)_2\,HPO_4 + aq \quad (9)$$

It may be seen from (4), (5) and (6) that the neutralization of the mother liquor with lime causes $CaHPO_4$ and $MgHPO_4$, *i. e.* citrate-soluble salts of phosphoric acid, to fall to the bottom.

Neutralization with ammonia according to the equations (7); (8) and (9) yields fertilizers containing P_2O_5 partly in water-soluble; partly in citrate-soluble form. Such fertilizers are by far higher in P_2O_5 than if lime is used for neutralization.

In the experiments of L. Berlin and V. Gutkina Inder borates containing mainly asharite ($2MgO \cdot B_2O_3 \cdot H_2O$) with an admixture of other calcium or magnesium compounds and of sesquioxides, sulphates, *etc.*, were tried as raw material. The B_2O_3 high asharite rock used in the experiment has the following chemical composition (in per cent): B_2O_3, 25.23; MgO, 25.70; CaO, 16.63; $(Na,K)_2O$, 1.18; SO_3, 1.31; Fe_2O_3, 0.79; Al_2O_3, 0.76; CO_2, 8.48; insoluble residue; 3.22.

Their main experiments L. Berlin and N. Zasypkina conducted with a concentrate from the poor clayey borates (hydroboracite rock) containing (in per cent): B_2O_3, 6.68; CaO, 26.37; MgO, 3.88; SO_3, 33.51; Fe_2O_3, 0.74; Al_2O_3, 1.90; CO_2, 2.51; insoluble residue, 8.70. In mineralogical composition the original rock consisted mainly of hydroboracite ($CaO \cdot MgO \cdot 3B_2O_3 \cdot 6H_2O$), clay, gypsum, anhydrite, calcite and glauconite.

Two kinds of phosphoric acid were used: one commercially pure obtained by the thermal method, and the other, containing impurities, obtained by sulphate extraction from a Chibiny apatite concentrate and from the phosphorite of Aktyubinsk. The «thermal» phosphoric acid was remarkable not only for purity, but also on account of its high content of H_3PO_4—71.4 per cent. The «extraction» acid from the Aktyubinsk phosphorite contained impurities and was low in per cent: 20.4 per cent of H_3PO_4; 1.4 per cent of SO_3; 1.5 per cent of $(Al; Fe)_2O_3$; 0.1 per cent of CaO. The «extraction» phosphoric acid from the apatite of Chibiny contained 34.1 per cent of H_3PO_4; 0.8 per cent of SO_3; 0.8 per cent of $(Al; Fe)_2O_3$ and 0.4 per cent of CaO.

Along with the decomposition of borates by phosphoric acid, the use of a mixture of H_3PO_4 and H_2SO_4 was also tried. This mixture, if applied in quantities that combine with calcium to form the sulphate, facilitates the precipitation of boric acid from solutions.

In 1931 S. I. Wolfkovich and A. Winokurova carried out preliminary tests on the «phosphoric acid» decomposition of datolites from North Caucasus deposits. L. Berlin; G. Gutkina and N. Zasypkina have studied the optimal conditions of the process in the laboratory.

Moreover, experiments under polythermal conditions (0—80° C) have been carried out for studying the solubility of boric acid in the presence of magnesium and calcium phosphates; as well as the kinetics of borate decomposition and the influence of burning the borate rock at 400° C upon the decomposition; filtration and washing-off the slime.

The laboratory experiments on the decomposition of asharite both by the «thermal» and the «extraction» phosphoric acid of different degrees of purity have shown that during this process nearly all of the boric acid (98—100 per cent) passes into solution.

The optimal conditions for the decomposition are as follows: the norm of the thermal phosphoric acid is 90 per cent: of the extraction acid, 100 per cent to the stoicheiometric proportions corresponding to the equations (1), (2) and (3).

The temperature has a much stronger influence on the kinetics and the degree of decomposition of borates in the case of phosphoric acid than in that of sulphuric acid. This is owing to the reduced dissociation of phosphoric acid, particularly in the solutions of low concentration, containing impurities. The optimal temperature in this case is 90—95° C. The duration of the decomposition process in the laboratory is about 60 minutes.

The solution obtained from this decomposition contained (in per cent): B_2O_3, 4.3; P_2O_5, 22.1; MgO, 4.7.

In the mother liquor after the separation of H_3BO_3 there were (in per cent): B_2O_3, 1.2; P_2O_5, 26.5; MgO, 5.

Ammonia is introduced to advantage in a ratio of 60—80 per cent of the stoicheiometric norm set by the equations (7), (8) and (9).

There has been made a set of experiments on the decomposition by phosphoric acid of clayey borates containing 6.68 per cent of B_2O_3. The borate portion of the ore (hydroboracite) is decomposed according to the following equation:

$$CaO \cdot MgO \cdot 3B_2O_3 \cdot 6H_2O + 4H_3PO_4 + aq = CaH_4P_2O_8 + MgH_4P_2O_8 + 6H_3BO_3 + aq \quad (10)$$

The other components of the clayey hydroboracite rock, like the components of other rocks, are decomposed according to the equations (2), (3), *etc.*

The ratio of B_2O_3 to P_2O_5 in the fertilizer varies from 0.11 to 0.22, according as one aims at maximum output of commercial H_3BO_3, or at increasing its content in the fertilizer.

The degree of the decomposition of the borate was not affected by substituting part of the phosphoric acid with sulphuric acid (of the same acidity in terms of the hydrogen ion). Only the CaO/B_2O_3 ratio in the solution declined in this case; the ratio of MgO to B_2O_3 remained nearly invariable.

The processes investigated in the laboratory must be verified on a set of other borate samples, and semi-industrial experiments are also needed for suitably modifying the equipment and the technological regime.

The laboratory work involved in this investigation was carried out by the authors in collaboration with G. Gutkina, N. Zasypkina, M. Kobrin and L. Gorizkaya.

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Received
6.IV.1944.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

GEOCHEMISTRY

IRON, MANGANESE, PHOSPHORUS AND SOME MINOR ELEMENTS IN THE ROCKS OF THE LOWER PERMIAN HALOGEN DEPOSITS OF THE BASHKIRIAN NEAR-URAL REGION

By N. M. STRAKHOV, E. S. ZALMANSON, R. E. AREST-YAKUBOVICH and V. M. SENDEROVA

(Communicated by D.S. Beliankin, Member of the Academy, 12. XII. 1943)

As it is known; within the Lower Permian deposits of the Near-Ural region of Bashkiria there are extensively developed halogen deposits; generally assigned to the Kungurian stage.

The lithological composition of these deposits is a complex one. The main rock are anhydrites—blue, grey, now massive and now thin-bedded; often spotted because of a considerable admixture of carbonates. Along the axis of the Cis-Uralian downwarping to the lower portions of the halogen beds thick layers of halitites are confined; composing the Lower Kungurian salt-bearing horizon. Along the western margin of downwarping (from the town of Ufa to Sterlitamak) the beds often show intercalations of carbonate rocks: dolomites, calcareous dolomites, sometimes limestones, now pure and now more or less sulphated. Along the eastern border of the Cis-Uralian downwarping the lower part of the halogen beds is replaced by terrigenous rocks, sandstones, clays, marls, occasionally with an admixture of sulphates. Westward of this eastern central terrigenous belt, further inland the halogen beds are cut by a series of long and relatively narrow tongues of clastic rocks (sandstones, aleurolites, clays); always markedly sulphated; sometimes with an admixture of halite; replacing more or less considerable packets of halogen sediments. This is the so-called Allakaev facies of the Kungurian; it represents submerged alluvial fans of rivers which were running down to the Kungurian lagoon from the adjacent East-Ural land.

An analysis of the distribution of the rocks named above shows that they were deposited in a vast; highly saline and sharply alkaline Cis-Uralian Kungurian lagoon fed from two sides: from the side of the Russian Platform sea; whence waters with a normal sea salinity or even somewhat higher were inflowing, and from the side of the Urals, whence fresh river waters were supplied; carrying with them clastic material and a series of mineral compounds leached out from the Uralian weathering crust. In the lagoon all the incoming waters and substances chemically dissolved in the latter were mixed up; and upon evaporation of the water the mineral ingredients were deposited and entered the composition of the corresponding facies of the lagoon.

It is no easy task to trace the chemical differentiation of matter in the lagoon, which cannot possibly be done unless a number of special investigations are performed.

The present paper deals with one of these, being concerned with Fe, Mn, P, Cr, Ni; V, Cu—elements which in the study of halogen formations are usually omitted from tests.

In order to solve the problem a special set of forty four specimens has been prepared; comprising practically all the principal types of the Kungurian rocks.

The table presents the figures obtained by the analysis. From these it follows that the carbonate rocks, both those deposited along the western margin of the lagoon (hole 5/11), and those in the central parts of the latter (holes 10/20; 42/2) are very poor in iron, manganese, phosphorus and copper; chromium is mostly absent, while nickel and vanadium are altogether lacking.

The anhydrites are likewise poor in the elements investigated, irrespective of the fact whether the specimens have been taken in the western marginal part of the halogen formation, the drainage area of the waters of the Russian Platform sea, or in its central parts. The halitites have not been analysed for Fe, Mn, P, Cr and other elements, but, judging from the data of N. Tageeva (1), they should not carry these elements and should repeat the picture shown by the anhydrites and carbonates.

The only facies that has yielded considerable quantities of iron, manganese and partly phosphorus and has always shown Cr, Ni, V and Cu in amounts approaching the clarkes of these elements and in some cases exceeding the clarkes are the terrigenous rocks of the eastern marginal part and the Allakaev facies; *i. e.* the submerged alluvial fans of the Uralian rivers.

The above outlined distribution of iron, manganese, phosphorus, vanadium, chromium, nickel and copper in the facies of the saline Kungurian lagoon of the Cis-Urals discloses the principal features of their geochemistry in this water body. Out of the two sources of feeding (the sea from the West and the rivers from the East), it is the latter that supplies the bulk of the elements listed above; the vast majority are brought in from the East, from the Urals, and consist of products of leaching out of Uralian rocks. Practically no Fe, Mn and other elements investigated were supplied from the West, the Russian Platform sea; as a result the carbonate and sulphate roks deposited along the western border of the lagoon do not contain these elements. Upon being brought into the saline and sharply alkaline ($pH \cong 8.8$) water of the lagoon, iron, manganese, phosphorus *etc.* rapidly coagulated and precipitated along with clastic, clayey and colloidal aluminium silicate material carried away by the currents of the lagoon. These elements hardly reached beyond the limits of terrigenous sedimentation, the lagoonal water was practically free of them, and this is why the chemogenous sediments contain neither vanadium, nickel, nor chromium, and carry only negligible amounts of Fe, Mn; P and Cu.

The migration of the latter elements to the central parts of the lagoon was not, however, a mere completion of the process of chemical differentiation, but was brought about by accessory processes.

It should be borne in mind that Fe and P are the common ingredients of the protoplasm of the phytoplankton which often contains also Mn and Cu. Passing into organisms, these elements were carried far beyond the limits of terrigenous sedimentation, and after the death of living individuals might settle as purely chemogenous sediment. It should be remembered, too, that Fe and Mn have easily mobile ferrous and manganous forms, while phosphorus passes into gaseous PH_3. In terrigenous silts with their strongly reducing medium, this conversion of iron and manganese to the ferrous and manganous forms; and of phosphorus to PH_3 undoubtedly takes place. Hence the reduced forms of these elements diffuse to the abyssal waters, whose currents may carry them outside the limits of the terrigenous sedimentation to the area of a purely chemogenous sediment, where they finally settle again.

In this manner through living matter and reduction processes in silts, iron, phosphorus, manganese and copper as it were «escape» beyond the limits assigned to them by the laws of chemical differentiation, and penetrate deep into the zone of chemogenous lagoonal sedimentation.

Comparing the above described behaviour of Fe, Mn, P and other elements in a saline lagoonal water body with their history, as we known it, in normal sea and fresh-water basin, it should be believed that in principle in all cases the same process of differential precipitation takes place, which, however, proceeds at a different rate and with different completeness. While in the freshened and

Content of Fe, Mn, P, Cr, V, Ni, Cu in the Rocks of the Cis-Ural Area of Bashkiria (in per cent)

Place of sampling	Fe	Mn	P	Cr	Ni	V	Cu	Notes
I. Carbonate rocks, dolomites, calcareous dolomites								
Hole 5/11 403— 411 m	0.020	none	undeterm.	undeterm.	none	none	0.005	
375— 383 »	0.083	»	0.035	none	»	»	0.010	
390— 398 »	0.042	0.062	0.026	»	»	»	0.002	
578— 581 »	0.063	none	undeterm.	»	»	»	0.005	
Hole 10/20 738— 748 »	0.44	»	0.018	0.0007	»	»	undeterm.	
989—1001 »	0.007	»	0.065	none	»	»	0.001	
1033—1043 »	0.44	0.38	0.065	0.0003	undeterm.	»	0.001	
Hole 42/2 658—663 »	0.72	0.30	0.109	none	»	»	undeterm.	
II. Anhydrites								
Hole 5/11 346— 349 m	0.35	0.015	0.035	0.003	none	none	none	
414— 472 »	0.040	none	0.033	0.0007	»	»	0.002	
Hole 10/20 738— 748 »	0.001	»	0.018	none	»	»	none	
906— 912 »	0.003	»	0.015	»	»	»	0.001	
932— 942 »	0.021	»	0.018	»	»	»	none	
Hole 42/2 245— 255 »	0.098	»	0.018	»	»	»	0.009	
410— 416 »	0.88	0.020	0.087	0.003	»	»	undeterm.	
410— 416 «	0.82	0.068	0.033	0.003	»	»	0.013	
432— 440 »	0.105	0.008	0.033	0.0007	»	»	0.0007	
Hole 1/23 429— 431 »	0.035	0.004	0.035	none	»	»	0.001	

Continued

Place of sampling	Fe	Mn	P	Cr	Ni	V	Cu	Notes
III. Clays								
Hole 42/2 455—457 m	3.51	0.082	0.073	0.014	undeterm.	none	undeterm.	Black clay
» 1/23 664—667 »	4.39	0.041	0.174	undeterm.	»	undeterm.	0.002	» »
» 3/25 1408 »	3.73	0.413	0.080	0.008	0.013	0.013	0.002	Black clay with vegetable remains
1421 »	0.90	0.101	0.040	none	none	0.003	0.001	Dark clay
1323 »	3.68	0.66	0.080	0.006	0.006	0.010	0.001	
1318 »	3.18	0.062	undeterm.	0.003	0.03	0.010	0.001	
1326 »	3.07	0.071	0.023	0.004	0.004	0.010	0.001	Cherry-red arenaceous clays of the Allakaev tongue
1323 »	4.17	0.053	0.022	0.003	undeterm.	0.012	0.001	
1395 »	4.17	0.061	undeterm.	undeterm.	»	undeterm.	0.003	
1252 »	2.96	0.102	0.061	0.006	0.013	0.012	undeterm.	
1325 »	4.06	0.062	0.082	0.006	none	0.010	0.002	
1324 »	undeterm.	undeterm.	0.012	0.001	undeterm.	0.005	none	
1336 »	2.85	0.032	0.051	0.004	none	0.010	0.002	
727 »	3.40	0.141	0.174	0.021	undeterm.	none	0.001	
IV. Sandstones								
Hole 3/25 729 m	undeterm.	undeterm.	0.07	0.006	0.006	0.008	none	Dark-grey fine-grained sandstone
1107 »	1.15	0.043	undeterm.	0.007	0.002	0.007	0.002	Red argillaceous sandstone
1403 »	3.18	0.72	»	0.008	0.040	0.010	0.040	Gray gravel sandstone

normal sea water bodies the differential precipitation stretches over several scores of kilometers and practically even in vast basins does not achieve completion, in the highly alkaline and saline lagoon the precipitation of Fe, Mn, Cr and other elements proceeds at a rapid rate, within a short distance from the inflow of fresh waters and with exceptional completeness. It is in this rapid precipitation of heavy minor elements near the point of their supply to the saline lagoon, and in the resulting clearing of the way for differential precipitations of lighter and stabler elements, such as F, Sr, Br, B, K, brought from the sea feeding the lagoon, that lies the specific peculiarity of the chemical differentiation of saline lagoonal water bodies, unlike the normal sea and fresh-water basins.

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Received
12.XII. 1943.

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· Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

BIOCHEMISTRY

ATMOSPHERE AS POSSIBLE SOURCE OF VITAMINS

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In my two earlier notes ([1], [2]) experiments are described from which it follows that: 1) various organs of green plants (germinating seeds, leaves, flowers, fruits) evolve into the atmosphere diverse and rather complex volatile organic compounds; 2) these phytogenic substances make up a constant, though quantitatively insignificant, component of the atmosphere throughout the growing period and wherever the surface of the Earth is covered by more or less profuse vegetation; 3) many of these substances serve as a good source of food for the most variable micro-organisms, by which they are readily assimilated directly from the air, enhancing their growth considerably; and, lastly, 4) on some less frequent occasions the phytogenetic volatile organic substances instead of stimulating the growth of micro-organisms inhibit it appreciably or even arrest it completely.

The conclusions cited above, and the two last in particular, make us face the question as to the rôle of the volatile organic substances evolved by plants in the life of higher organisms, and especially in that of man.

This question is quite consistent, for studies carried out in the field of comparative physiology and biochemistry within the last two or three decades revealed an amazingly profound resemblance between the intracellular processes of assimilation and dissimilation in all recent organisms, irrespective of how remote from one another taxonomically or morphologically those organisms may be. Suffice it to mention the recent advances in the studies of respiration and fermentation chemistry, of the mechanism of fermentative phenomena, of the chemical nature and the part played in physiology by vitamins. It is the modern works on vitamins ([3]) that especially abound in examples of physiological and biochemical proximity between organisms standing widely apart as to their taxonomic position.

When approaching the problem we are interested in; the first thing we must keep in mind is that many of the volatile organic substances evolved by plants are an abundant source of nourishment not for a single small group of highly specialized microbes only, as it is the case, say, for the simplest among the carbohydrates, the methane, but for a wealth of most diversified living beings belonging to bacteria, actinomycetes and fungi.

This circumstance is, as has already been pointed out ([2]), evidence of a rather high nutrient quality of the substances evolved into the air, and, consequently, of their rather complex chemical composition.

It is known that more or less complex organic nutrient substances, say, many carbohydrates and aminoacids, are equally well assimilated by most of the recent organisms inhabiting the Earth, beginning with bacteria and up to man. In the cells of any living organism these compounds are known to experience similar transformations, participating directly in physiological and biochemical processes likewise similar as to their importance for those organisms.

On the ground of numerous examples of this kind we may infer with a sufficient degree of probability that the phytogenic organic components of the atmosphere that are assimilated by various micro-organisms, may in some cases as readily, or even more so, be absorbed and assimilated by the cells of other animals. And this seems to be especially true of those tissues which are especially adapted for the gaseous exchange, being in permanent contact with the air, say, of the cells of respiratory epithelium.

Of outstanding interest is the question as to the importance of the phytogenic organic substances of the atmosphere for the epithelium of the pulmonary alveolae, which so often becomes the object of attacks on the part of the worst enemy of mankind, the tubercle bacillus. Neither the insignificant content of these substances in the air, nor the seasonal mode of occurrence in the latter, give us right to deny the possibility of an important rôle played by them in the life activity of the cells of pulmonary epithelium, in the first place by increasing its resistance to infection.

It stands to reason that because of the infinitesimal concentration of those compounds, their value as of building or energy producing material should be recognized as being vanishingly small. It is not impossible, however, that some of the phytogenic organic components of the atmosphere, being absorbed by the cells of the lung tissue, perform in it, and possibly in the rest of the organisms tissues as well, the functions of accessory food factors, or vitamins*.

Let us recall that 3—4 kg of air pass through the lungs of an adult person within a 24-hour day. Suppose that the air that enters the lungs contains but one millionth of some readily absorbable organic compound; its daily supply to the organism will then make up about 3—4 mg, thus reaching a figure more than sufficient for this substance to act as a vitamin.

Neither is our hypothesis disproved by the seasonal appearance of the phytogenic substances in the atmosphere, for all vitamins that are obtained by an animal organism from the vegetable kingdom, at our latitude at least, are not being formed by the green plants throughout the year, but during a more or less restricted growing period only. Besides, in spring their reserves in the atmosphere are undoubtedly supplemented at the expense of the volatilization from the soil of a part of the phytogenic organic compound that are being formed there; this must take place especially during the warm und sunny days when the soil is well heated. In autumn considerable amounts of various organic substances are supplied into the air from decaying leaves and other vegetable organs.

Several arguments may be advanced in favour of the assumption that some of the phytogenic organic components of the atmosphere are acting as vitamins.

1. It seems highly improbable that, being in the course of considerable geological periods in a constant energetic exchange with the surrounding atmosphere, the organism of man and of animals failed to involve in the chemism of its physiological processes at least some of the most chemically active phytogenic organic compounds. And this is the more improbable as these compounds re-occur in the atmosphere from year to year, with a regular periodicity, and are, as we know at present, readily absorbed and assimilated by the protoplasm ([1],[2]).

We have here a wide scope for the work of natural selection which is regularly fixing the interaction between the organism and the chemical agents of the environment in all cases, where the organism is likely to profit by this interaction, be the advantage secured even so small.

One cannot help thinking that the delight caused by the fragrance of a flower or by the bracing smell of a pine-forest is a kind of physiological signal that makes aware of some still unaccountable beneficial influence of the phytogenic substances of the atmosphere upon the life activity of our organism.

2. The high physiological and biochemical activity of a number of volatile organic substances evolved by plants is evidenced by the well-known facts of their more or less pronounced injurious effect produced upon the human organism

* The phytohormones which in some respects are close to the vitamins, do not lose their physiological activity when acting upon a plant from the air as vapours.

in case their concentration in the surrounding atmosphere happens to exceed the normal considerably. This is especially true of substances evolved by flowers. In the interpretation here advanced, these phenomena may well be compared with hypervitaminoses.

Put together with numerous analogous data bearing on aqueous solutions of various physiologically active substances, these facts give us ground to assume that, when contained in the atmosphere in small amounts, these very volatile substances may have a stimulating effect upon some intracellular processes, acting in this case as chemical agents beneficial to the organism.

3.The salutary effect of the air of woods (especially of pine-woods), of steppes and in general of vast areas overgrown by a diversified and abundant vegetation has been known long since. It is known as an agent preventing pulmonary consumption or aiding to arrest this disease at its initial stages. This fact which until recently defied satisfactory interpretation, may easily be understood if we are to assume that some phytogenic organic substances of the atmosphere are necessary for our organism (as well as for many terrestrial animals) as accessory food factors, or vitamins*.

From this point of view we can also easily explain the beneficial effect of d r y air on weak or affected lungs: the drier the air, the greater the quantity of phytogenic organic substances it contains. Precipitations of any kind, rain, fogg, dew, by washing the air, eliminate at the same time a considerable part of organic admixtures. Besides, the latter are evolved by the plants in much larger amounts when the weather is dry and hot, than when it is wet and cool.

It may prove, after all, that among other causes responsible for the wide spread of lung tuberculosis, this disease is caused also by a peculiar kind of avitaminosis, an avitaminosis of the lungs, connected with the deficiency in the air of our towns of phytogenic organic substances?

And, lastly, the wide spread of tuberculosis among cattle may be connected with the gradual decrease of acreage under natural pasture, with the generally adopted keeping of cattle in stall.

In order to solve these questions, the phytogenic organic substances of the atmosphere are to be most thoroughly investigated from the chemical, physiological and medical point of view.

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Received
24.XI. 1943.

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* I will not dwell here upon the question as to those phytogenic substances of the atmosphere which inhibit the growth of micro-organisms. If they are of any importance for the organism of man and animals, their rôle is obviously quite different. Some of them may possibly prevent the development of microbes on the mucous of respiratory organs and on the epithelium of the pulmonary alveolae.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

GEOLOGY

GENETIC SIGNIFICANCE OF GRANULOMETRIC COMPOSITION OF CLAYEY SEDIMENTS

By L. B. RUKHIN

(Communicated by A. A. Polkanov, Member of the Academy, 12. II. 1944)

The question of the genetic significance of granulometric composition for clayey rocks is at present hardly considered, in spite of the fact that the genetic significance of granulometric composition for coarser-grained rocks (sands, in particular) may be considered to be proved ([1–3]).

The genetic interpretation of the data on the granulometric composition of clays is much more complicated than that of sands. In the first place, owing to the laminar shape of some clayey particles, their small dimensions and brittleness, the results of the granulometric composition of clays depend largely on the nature of the preliminary treatment of the specimen. Secondly, the granulometric composition of clays does not remain fully constant, varying with time in connexion with a certain change in the structure of clays (ageing of colloids). These two agents considerably reduce the genetic significance of granulometric composition for clayey rocks. The procedure of the granulometric analysis of clays is, moreover, considerably more complicated than that of the analysis of sands, which prevents this method from being applied on a wide scale. It should also be mentioned that at present the results of the granulometric analysis of clays are expressed in fractions of a very large volume. Thus, if in the analysis of sands the ratio of the final dimensions of fractions is often equal to $2^1/_2$ or even $2^1/_4$, in the analysis of clays it is at best fractions with a ratio of the final dimensions equal to 2 or even 5 that are used.

In spite of these peculiarities, it is possible even now to point out some genetic regularities of the granulometric composition of clays. Let us briefly discuss the granulometric composition of the recent marine, lacustrine and river clayey sediments.

Littoral clayey sediments have within recently been described in detail by Winkler ([4]) for the «watten» region of N-Western Germany. From a consideration of the granulometric composition of the sediments of this region it follows that it falls into a number of zones stretching along the shore. The granulometric nature of these zones is determined by the 0.2—0.002 mm fraction attaining in it a total of 70—80 per cent. The ratio between the values of these fractions depends on the position of the zones with regard to the shore line. The typical sediments of watten are characterized by a very considerable content of the fraction smaller than 0.002 mm, making up on the average 36 per cent. Along with this, the sediments of watten contain approximately as many particles of the 0.2—0.02 mm fraction with a small development of fractions larger than 0.2 mm (on the average about 1 per cent). It should also be noted that the total content of fractions smaller than 0.01 mm in the sediments of watten reaches on the average 60 per cent.

The granulometric composition of shallow-water clayey sediments is greatly variable; it depends not only on the depth of the basin in a given region, but on a whole complex of sedimentation conditions, as well. The clayey sediments of

about the same granulometric composition may therefore occur both in the immediate proximity of the shore line, and at a considerable depth within the shelf. However, for any sedimentation area taken separately the number of particles smaller than 0.01 mm in the general case markedly increases. It is very characteristic, however, that even silty sediments developed at a depth of over 200 m, *e. g.* the sediments of the Motovsky bay ([5]), are as fine-grained as the sediments of watten. The exceptionally fine-grained nature of this type of sediments is illustrated also by its comparison with the sediments of different lagoons and bays.

The granulometric composition of the recent terrigenous silts and of the red deep-water clay is approximately the same.

The granulometric composition of terrigenous silts is as follows: the content of particles larger than 0.2 mm is, as a rule, very small; the content of the 0.2—0.02 mm fraction makes up about 20—30 per cent; the content of 0.002 to 0.001 mm particles is equal to 30—40 per cent, as well as that of particles smaller than 0.001 mm.

The granulometric composition of red deep-water clays varies approximately within the same range as that of terrigenous silts. There is a great resemblance between the average granulometric composition of red deep-water clay and terrigenous silts in adjacent areas of the ocean bottom. Thus, for the central part of the Atlantic ocean the average content of fractions smaller than 0.002 mm in terrigenous silts is 53.5 per cent, and in red clay, 54 per cent. The content of the 0.001—0.002 mm fractions is 23.0 and 28.6, respectively. The content of other fractions is also approximately the same. When comparing the granulometric composition of the sediments of watten and of deep-water deposits, it is easy to see that although the latter are more fine-grained, but to a considerably lesser degree than it should be expected. Such a coarse-granularity of deep-water sediments may be put down to the coagulating effect of sea water upon clay suspensions. The aggregates of particles formed owing to coagulation seem to be so stable as to be but partly destroyed by a treatment of the specimen preceding granulometric analysis. Therefore the granulometric composition of marine sediments formed by a sedimentation in sea water of suspensions with a different granularity is about the same. This assumption is confirmed by the granulometric composition of freshwater lake sediments.

The granulometric composition of sediments of recent lakes is far from being sufficiently studied, partly because of a considerable admixture of organic material which distorts the picture of the granulometric composition. Therefore in order to characterize the granulometric composition of lake deposits it is preferable to use data on the granulometric composition of doubtless ancient lacustrine deposits. Such are *e. g.* the banded clays and deposits of the late-glacial Baltic basins ([8]). These deposits are characterized by a considerable content of particles smaller than 0.001 mm, amounting to 65—70 per cent. Similar values ([9-11]) are characteristic also of the winter layers of banded clays. In this way the lacustrine sediments formed at a depth of only some tens of meters are considerably finer-grained than the deep-water ones deposited at a depth of several thousand meters. In spite of the fact that the literature contains description of the granulometric composition of many deep-water sediments, not a specimen as fine-grained as those of the lacustrine sediments mentioned above could be found among them. This goes to confirm the assumption as to the influence of coagulation upon the granulometric composition of sediments.

The granulometric composition of river clayey sediments (flood deposits) has been recently studied by several authors ([12, 13]). According to the data available, the sediments considered are characterized by a content of the fraction of particles smaller than 0.01 mm equal to about 80 per cent, of which 20—30 per cent fall to the share of particles smaller than 0.005 mm. The content of particles smaller than 0.002 mm has been reported only for sediments of small rivers and was found to be on the average equal to 12 per cent. It seems that these data are characteristic of river clayey sediments in general, since analogous data have been reported for deposits in suspension for different rivers. For instance, according to

the data of Glushkov ([14]), on the average for four rivers (Amu-Darya, Syr-Darya, Chu and Ili) the content of particles smaller than 0.05 mm was 64 per cent in 26 samples, of which about 25 per cent fell to the share of particles smaller than 0.005. In case these characteristic features of the granulometric composition of clayey river sediments will be confirmed, it should be believed that they are considerably coarser-grained than the corresponding marine and lacustrine sediments.

The recent littoral and deep-water marine clayey sediments, lacustrine and river sediments thus have a specific granulometric composition, according to which they can be distinguished; it may also serve to determine the conditions of deposition of ancient clays.

For instance, high-quality fine-grained refractory clays characterized by a high content of particles smaller than 0.001 mm (up to 70—90 per cent) in the Borovichi, Latna and Chasov-Yar deposits, are typical lacustrine sediments. This view is in good agreement with the mode of occurrence of the clays and the origin of the enclosing rocks.

The development of the granulometric method as applied to ancient clayey rocks is possible only provided a uniform procedure be used for the analysis and, which is most important, provided it be worked out in greater detail. This should be taken into account especially when working out the program of investigation of recent sediments. The method of analysis now applied gives fractions of too large a volume and does not require the separation of particles smaller than 0.01 mm. Such a system is obviously obsolete and does hot satisfy modern requirements of a granulometric analysis of clays.

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Received
12.II.1944.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

MINERALOGY

AEGIRITE IN THE QUATERNARY DEPOSITS OF THE MOSCOW REGION

By S. G. SARKISSIAN

(Communicated by D. S. Beliankin, Member of the Academy, 27. XII. 1943)

Little attention has so far been given to the study of the Quaternary deposits of the Soviet Union by a petrographic and mineralogical method. A wide application of this method would, however, largely contribute to a stratigraphical subdivision of Quaternary deposits according to their mineralogical components, and be helpful in finding out the sources of formation and the ways of removal of loose material, and in retracing the conditions of sedimentation during the Quaternary.

In the course of his mineralogical investigations of the Quaternary deposits of the Solnechnogorsk district of the Moscow region (according to the materials by V. M. Danshin), the author came across aegirite. This mineral is present in the form of prismatic grains with a striation parallel to the edge of the prism. The ends of the grains are obtuse; the colour is deep-green. Pleochroism is slight, in greenish shades. $N_g = 1.784$, $N_m = 1.776$, $N_p = 1.745$. Extinction angle, 2°. Size of grains, 0.15 to 0.25 mm.

A comparison of the aegirite discovered along with that occurring in the loose deposits of the Lovozero tundras of the Kola Peninsula reveals a striking resemblance between the two. The influence of the Kola Peninsula is expressed in the presence in the Quaternary deposits of ramsayite (one grain).

In this way we gain a clear idea of the long way passed by the terrigenous material of the Quaternary deposits of the Moscow region, from the sources of supply to the sedimentation area.

It is most desirable that petrographic and mineralogical analyses of the Quaternary deposits of this Union, of those of the Moscow region in particular, be continued, for they may furnish new valuable data for the knowledge of the palaeography of the Quaternary.

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Received
27.XII. 1943.

Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

MINERALOGY

PICITE FOUND IN THE KERCH IRON ORES

By A. V. SIDORENKO

(Communicated by A. E. Fersman, Member of the Academy, 19. XI. 1943)

Phosphate minerals are of frequent occurrence among the iron ores of the Kerch and the Taman Peninsula; the least studied among them are basic ferric phosphates, of which for the given deposit only bosphorite, $3Fe_2O_3 \cdot 2P_2O_5 \cdot 17H_2O$, and azovskite, $3Fe_2O_3 \cdot P_2O_5 \cdot 12H_2O$, are known. The former has been described by S. Popov, the latter was discovered by N. Efremov in 1937, but has as yet been insufficiently studied. The deposits studied by us are likely to contain much larger amounts of ferric phosphates. Their investigation will contribute to a better knowledge of the geochemistry of phosphorus in the iron ores of sedimentary origin.

A basic hydrous ferric phosphate, discovered by the author in the Kamysh-Burun mine, the Kerch Peninsula, is described below.

The mineral forms nodules among a friable oolitic ore in the upper portion of the ore-bed. The colour is brick-red, sometimes brown-red. Streak, brick-red. Hardness, 2. Brittle, breaks easily. Specific gravity as determined with the pycnometer at 15°, 2.39 (the mean of 2.40 and 2.38). Under the blow-pipe it easily fuses into a black bead; fusibility, 2.

It is easily decomposed by sulphuric, nitric and hydrochloric acid; it is stable to boiling, and does not coke. The mineral occurs in two varieties; the brick-red variety gave the following results (Table 1).

Table 1

Brick-red Variety

Components	Results of analysis I	Results of analysis II	Mean	In pure substance	Per 100% pure substance	Molecular quantities	Molecular ratios	Theoretical composition from the formula $2P_2O_5 \cdot 9H_2O$
CaO	2.39	2.38	2.39	1.86	1.91	0.03405	0.2	—
MgO	—	not determ.	—	—	—	—	—	—
MnO	traces	not determ.	—	—	—	—	—	—
FeO	—	not determ.	—	—	—	—	—	—
Fe_2O_3	47.38	47.40	47.39	47.39	48.44	0.30033	1.85	51.23
P_2O_5	22.50	22.62	22.56	22.56	23.05	0.16227	1.00	22.78
H_2O below 110°	15.21	26.12	26.03	15.21	15.54	0.86333	5.32	25.99
H_2O above 110°	10.82			10.82	11.06	0.61444	3.79	
CO_2	0.39	0.45	0.42	—	—		—	—
SiO_2	1.00	not determ.	1.00	—	—		—	—
SO_3	—	—	—	—	—		—	—
Total	99.70	—	99.79	97.84	100.00	—	—	100.00

From the figures of the analysis the following formula can be deduced:

$$2Fe_2O_3 \cdot P_2O_5 \cdot 4H_2O \cdot 5aq$$

or, the total water being taken into account,

$$2Fe_2O_3 \cdot P_2O_5 \cdot 9H_2O$$

Aside from the brick-red variety, the author studied the brown-red, darker variety which showed a composition closely approaching that of the former cited (Table 2).

Table 2

Brown-red Variety

Components	Results of analysis
CaO	3.17
MgO	traces
MnO	0.01
FeO	—
Fe_2O_3	47.28
P_2O_5	21.99
H_2O	24.76
Insoluble residue	2.12
CO_2	not determined
Total	99.33

The dehydration curve shows that the greater part of the water is given off at low temperatures. Thus, upon heating to 165°, 22.43 per cent water of the total 26.03 per cent water contained in the mineral was evolved. The remaining water is given off at a slower rate, owing to which a small kink of the curve is observed at 165°. Such a nature of dehydration is observed in most of the basic hydrous ferric phosphates.

Under the microscope the mineral is homogeneous. The colour is brown-red. In thin-sections the substance is translucent. There is no birefringence. The refractive index as determined with immersion liquids varies from 1.677 to 1.680. Very small grains of calcite are sometimes encountered, which is also brought out by chemical analysis (0.93 per cent $CaCO_3$).

Table 3

Components	Mineral from Kamysh-Burun	Picite from the Eleonora Mine
CaO	1.91	—
Al_2O_3	—	1.00 } 47.50
Fe_2O_3	48.44	46.50 }
P_2O_5	23.05	24.47
H_2O	26.60	28.03
Sp. gravity	2.39	2.83 after A. Nies and 2.39 after Boricky
Hardness	2	3—4
Colour	Brick-red	Yellow-red
Occurrence	Among oolitic iron ore	Among brown iron-stones

As seen from Table 3, the chemical composition and properties of the mineral described are similar to those of picite, a mineral recorded by A. Nies in 1881 in the Eleonora Mine at Dünnberg, being distinguished from the latter only by a low content of CaO which seems to be present in an adsorbed state, by the absence of Al_2O_3 and by a somewhat lower hardness, which may easily be accounted for by the non-crystalline structure of these substances. There is therefore good reason to consider the mineral here described as picite, by which name it will be designated in the subsequent.

Origin. The mineral occurs in close paragenetic relation with oxykerchenite. All the specimens examined by the author show small bands of oxykerchenite, occasionally passing to picite. A comparison of the chemical analyses (Table 4) of oxykerchenite and picite and the paragenesis of the minerals go to support the view that the latter mineral has been formed as a result of weathering of oxykerchenite, which consisted in the leaching of the RO and P_2O_5 oxides and destruction of the crystalline lattice. Such a process of weathering was proved by the works of the author and of F. V. Chukhrov for derivates of anapaite.

Table 4

Components	Theor. composition of oxykerchenite	Chemical composition of the mineral per 100% pure substance
CaO	4.69	1.91
MgO		—
MnO		—
Fe_2O_3	42.24	48.44
P_2O_5	28.12	23.05
H_2O	24.95	26.75
Total	100.0	100.15

In 1910 S. Popov recorded for the deposit we are concerned with two varieties of vivianite: common vivianite and paravivianite, *i. e.* vivianite containing up to 3 per cent RO (CaO, MnO). The two varieties of vivianite yield different weathering products: vivianite passes to non-crystalline bosphorite, and paravivianite, to crystalline γ-, β-, α-oxykerchenites. The conversion of paravivianite does, probably, not terminate with oxykerchenite but proceeds under the formation of a non-crystalline phosphate, picite, an analogue of bosphorite with regard to its origin.

The process of conversion of vivianite and paravivianite may be schematically represented as follows:

vivianite → γ-kerchenite → β-kerchenite → α-kerchenite → bosphorite:

paravivianite → γ-kerchenite → β-kerchenite → α-kerchenite → oxykerchenite → → picite.

As far as we know, picite is found in Kerch iron ores for the first time in the USSR.

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Received 19.XI.1943.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

ECOLOGY

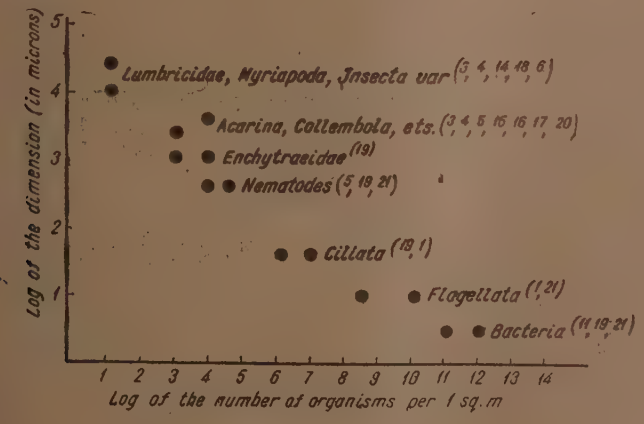
CORRELATION BETWEEN SIZE AND NUMBER OF SOIL ANIMALS

By M. S. GHILAROV

(Communicated by I. I. Schmalhausen, Member of the Academy, 10. X. 1943)

If we were to compare the abundance (number of individuals per 1 m²) of soil animals of various size, classed into natural size groups, irrespective of their systematic position and kind of food, we would soon become aware of an inverse relation between the number of individuals per unit area and the size of these individuals.

This statement is well illustrated by the graph (see figure) which has been plotted on the ground of records made at various regions with moderate climate.



For convenience sake, along the abscissa are plotted the logarithms of the animals' dimensions (in microns), and along the ordinate, the logarithms corresponding to the order of their mean frequency (per 1 m²) in a soil layer about 25 cm thick.

Besides animals, the graph includes bacteria, since the overwhelming majority of soil bacteria are deuterotrophic, like the animals.

The figures in brackets next to the names of the group of organisms correspond to the reference number in the list of literature cited. For more detail on literature dealing with the frequency of soil-fauna, see ([2], [3], [15], [17], [20]).

The graph illustrates a definite regularity in the distribution of the representatives of soil-fauna over a unit area according to a given size group: the most numerous are organisms of smallest dimensions.

Such a correllation between the size of soil animals and their number should, to our opinion, be accounted for by the following circumstances.

For the subsistence of soil inhabiting animals a whole complex of conditions is necessary, *viz.*: presence of food, water supply, access of oxygen, *etc.* Lack or sharp deficiency of any of these factors are fatal for the organism. And the probability of all these conditions being present simultaneously is the higher, the lower is the demand for them.

Therefore the smaller the organism, the higher the probability of finding them and of surviving.

This statement is especially true for soil animals* if we take into account that most of them are saprophagous ([2], [15], [19]), and that the matter they feed upon, as well as air and soil moisture, are in dispersed state.

Aside from this chief cause of the reverse relation between size and number of soil animals, there are others, too. Thus, the rate of mortality is higher at earlier stages, and therefore, the number of smaller individuals of younger stages of a given species is larger.

The ontogenesis in larger forms is, as a rule, of longer duration than in smaller ones**.

This means that larger organisms are subject to the influence of the environment [according to Chapman ([10]), suffer «the resistance of the environment»] during a longer period of time preceding the reproduction period. Owing to this, the probability for them to reach definitive dimensions and leave progeny is lower than for small ones.

In the particular cases of the relation predator—prey [of «food chains» ([12])] the former must be stronger and, as a rule, larger, and less numerous than the latter (Elton's «pyramid of figures»). It should also be taken into account that larger organisms need not only a greater total amount of food, but there is also a definite relation between the size of an organism and the size of the food units consumed by it (provided the feeding habits of the objects compared are similar).

If the food is disproportionally small, the energy spent on feeding does not pay (this refers also to the water basins used as sources of water, *etc.*).

From the above considerations it is easy to understand why the vital space [«individual area», according to S. A. Sewertzoff ([7])] of larger organisms should, as a rule, be wider than that of smaller ones.

From the graph adjoined it is also obvious that the «biomass» of soil organisms belonging to different natural dimensional groups is of about the same order; the product of the total number of organisms of a given size by their linear dimensions raised to the third power, are magnitudes fluctuating within a small range.

This is evidently due to the fact that organisms of various dimensions, living in the soil, occupy there quite different «media of habitation». Thus, for example, the medium for soil inhabiting *Protozoa* is not the soil, as a whole, but only drops of ground-water.

Therefore, there are no specific «soil» species of *Protozoa* which are not met in fresh-water basins ([21]); both for those inhabiting water basins and those living in the soil the «vital space» is restricted to drops of water.

As a medium for *Microarthropoda*, *Acarina*, *Collembola etc.*, serves not the soil as a whole, but cavities, interspaces between solid bodies, fissures, root traces ([3], [15]). And only bigger invertebrates, capable of actively making their way through the soil, inhabit the soil as a whole.

The soil biocoenosis is thus subdivided into separate categories characterized by the dimensions of the animals entering their composition.

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* Soil biocenoses are characterized by the stability of their composition ([13]), while the number of their components fluctuates within a rather narrow range ([9]).

** This statement holds true as a general regularity, for forms closely similar in their organization.

{The regularity deduced from the correlations between the size and the number is especially conspicuous for the animal components of soil biocoenosis; it is, however, undoubtedly of more general character, and holds essentially true for any kind of biocoenosis.

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Received
10.X.1943.

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Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS
1944. Volume XLIII, № 6

EXPERIMENTAL MORPHOLOGY

ON THE MECHANISM OF ACTION OF THE PARATHYROID HORMONE ON THE BONE TISSUE IN EXPERIMENTS *IN VITRO*

By A. W. RUMJANTZEW and L. F. BEREZKINA

(Communicated by I. I. Schmalhausen, Member of the Academy, 17. XII. 1943)

A series of investigations carried on during the recent years have shown that, after the injection of sufficient doses of parathohormone, osteitis fibrosa may occur in the bones of young animals ([1–4]). Immediately after the injection of the hormone a considerable number of osteoclasts dissolving the trabecules appear in the membraneous and trabecular bones; as a result, cavities (cysts) are formed, filled with fibrous tissue of the mesenchyme type. This phenomenon in embryos has been carefully analysed by Ivanova ([5]) in this laboratory.

Seley ([6]) in 1932 suggested the idea that parathohormone acts directly upon the bone tissue, stimulating the formation of osteoclasts and processes of bone tissue absorption. This hypothesis encountered a number of objections. On the ground of his own experiments ([7]), as well as of those of his collaborators and of a number of other writers, Tweedy considered it possible that the parathohormone chiefly acts on the kidney tissues, while the changes appearing in the bones should be considered as a phenomenon of secondary order. Collip ([8]) later subscribed to this point of view. In a number of convincing experiments Seley ([9]) has shown, however, that the injection of parathohormone to nefrectomised animals increases their osteoclastic activity. But, inasmuch as osteoclastic activity is likewise increased after nefrectomy alone, the question as to the site of attack did not receive sufficient clearness.

Silberberg ([10]) has recently advanced very interesting suggestions concerning the development of the osteoclastic reaction. Experimenting with estrogenes, he was able to establish that phenomena similar to osteitis fibrosa may also arise after the injection of estrogenes (theelin). As estrogenous substances act upon hystogenesis of different tissues, Silberberg ([10]) arrived at the conclusion that the osteoclastic reaction is likewise a consequence of estrogene activity. Nevertheless, the question of whether the effect of estrogenes on the bone hystogenesis is a direct one, or their action is effected through the agency of the parathyroid gland, remains obscure. In fact, after injection of estrogenes the content of Ca in the organism increases, and this may undoubtedly tell upon the functions of the parathyroid gland. In the author's opinion, the method of tissue cultures is likely to yield very reliable data for solving the question connected with the mechanism of the action of the parathyroid gland.

If the osteoclastic reaction is brought about in the bone fragments of tissue *in vitro*, then the question as to the direct action of the parathohormone will immediately receive a positive solution. In the case of success it will simultaneously be possible to approach the problem of whether the parathohormone acts upon the

skeletogene mesenchyme directly, or the osteoclastic reaction develops in the presence of parathohormone as a consequence of disturbances in the correlations between the components of the bone tissue.

Method. Fragments of the femur of a chicken embryo 8—16-day-old were explanted into a plasma saturated with parathohormone. The saturation was effected in different ways.

Series I. 20 units of hormone were daily administered in the course of 9 days to a cock; 100 units were injected on the tenth day, and on the eleventh, plasma was taken.

Series II. The hormone was added to a plasma taken from a normal cock during the preparation of the culture at amounts from 2 to $^1/_{50}$ units per culture.

Series III. 100—170 units of hormone were injected into the blood of a cock; the plasma was obtained in three series. The cultures were fixed every second, third, fifth and sixth day in Zenker's liquid, decomposed into sections and dyed by different methods. The best results were obtained by Azan according to Heidenhein's method.

Series I and II failed to give any positive result, since by their cellular composition the cultures did not differ much from the control cultures prepared on pure plasma.

Series III gave the following definite results. After explantation in the control cultures, an intense growth of the osteogenous mesenchyme on the side of the periost, as well as of the endost begins around the fragment. This mesenchyme is not only formed as a result of the mobilization of the reticular tissue present in the developing bone marrow, but also from the mesenchyme which is to be found among the trabecules of the bone. It is joined by the osteoblasts distributed on the surface of the trabecules. When migrating to the surface, the mesenchyme carries with it the cells of the bone marrow. We were unable to establish the fact of the participation of the cartilaginous cells in the formation of typical osteogenous mesenchyme. If a small cartilaginous piece was left, then the mesenchyme cells began quickly to grow into it, apparently dissolving the ground substance of the cartilage. In this case, the cartilaginous cells, as a rule, quickly degenerated. But, unlike the control cultures, the presence of large rounded cells, mostly having 2 to 4 nuclei, could be observed in the growth area of the experimental cultures of the III series, 24 hours later. Many typical osteoclasts could be at once found in the internal parts of the grafts, especially in those cultures where the graft was taken from an older embryo.

The typical structure of the nuclei and the slight acidophylic protoplasm of polynuclear cells present in the growth area, as well as the character of its colour, prove that these cells of the growth area are osteoclasts that have migrated into the medium.

It is important to note the following detail. In cultures from the bones of 8—12-day-old embryos we found chiefly osteoclasts with 2 to 4 nuclei, whereas in cultures from the bones of 16-day-old embryos we often found forms having a large number of nuclei. It may be maintained that in experimental cultures the osteoclasts appearing on the second day are to be found in larger numbers than in the control where they appear as single specimens.

These osteoclasts have, undoubtedly, been formed anew. In the preparations, all the transition stages from the mesenchyme cells to the osteoclast could be found in the mobilized mesenchyme.

Thus, *in vitro*, it is possible to obtain an intensive formation of osteoclasts as it takes place *in vivo*, in the bones of young animals. In other words, the parathyroid hormone has a definite morphogenetic effect upon the osseous tissue isolated from the organism. This morphogenetic effect, however, cannot be considered as an immediate action of the hormone on the osteogenous mesenchyme. We have made experimental preparations of pure cultures of the osteogenous mesenchyme in a plasma saturated with hormone, but we failed to obtain anything that would resemble the formation of osteoclasts. Consequently, the presence of those correlations and interchanges which are established in the developing system of the bone

between its tissue components, is necessary to bring about the action of the parathohormone.

The question arises, however, what are then the tissue agents that should be taken into account in the first line? One might think of the cartilage. Under normal conditions the osteoclasts appear mostly under the cartilagenous plate of the bone, and our bits always contained cartilage. As the administration of parathohormone to animals suffering with rickets, in which the cartilaginous plate is strongly developed, as well as combined administration of parathohormone and vitamin D have shown ([11]) that the osteoclasts are in all the cases formed in the same way as under normal conditions, it should be inferred that the presence of a cartilage is not responsible for this histogenetic reaction. Our grafts contained various amounts of cartilage, but this did by no means affect the quantity of the osteoclasts that appeared.

It may be assumed that the Ca mobilized from the bone tissue plays no decisive part either, for the bones of animals suffering from rickets contained it in very small amounts and the parathohormone does not mobilize it, but the osteoclasts appear nevertheless. An addition of Ca salts to the medium also failed to cause the appearance of cellular forms that would resemble the osteoclasts, which has been demonstrated by our preliminary experiments.

The osteoclasts are formed not unless the plasm is saturated with the parathohormone, and the latter must be in a special condition, at that. We are brought to this conclusion on ground of the negative results of series I. This active condition seems to be maintained for a short time in the blood, because a day later (II series) the plasm of a previously treated animal also loses its activity.

Thus, it is possible to show with the help of tissue cultures that the parathohormone actually affects histogenetically the osteogenous mesenchyme, but this reaction appears only in the system of bone tissue.

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Received
17.XII.1943.

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Prix $ 0.50